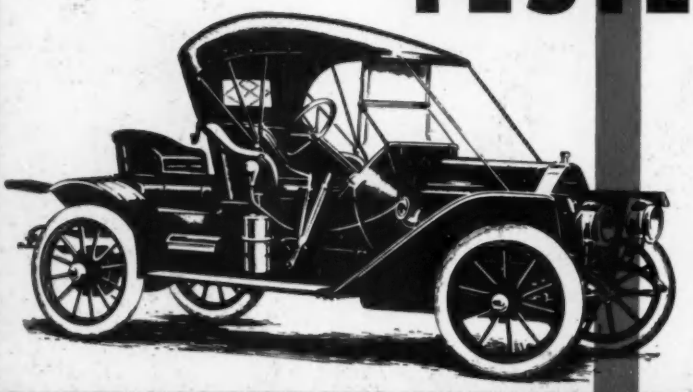
SAE Journal

IN THIS ISSUE . . .

OCTOBER 1957

Published by The Society of Automotive Engineers

YESTERDAY...



when compression ratios were 3 to 1, any good oil ring would do...as in this classic Ohio motor car of 1911. The manufacturer advertised that he built only two cars per day and subjected each car to a 150-mile road test before delivery. Three-passenger roadster illustrated sold for $2,150, fully equipped with hand crank and gas lamps.

TODAY...

It takes the PC type "98" chrome oil ring!

The Perfect Circle Type "98" Chrome oil ring was specifically designed to meet the exacting demands of today's high-compression engines. Featuring universal application, bottomless and conventional grooves, all depths, the PC Type "98" oil ring was the first to have a patented side-sealing action with multiple tiny springs that exert both side and radial pressure. And of utmost importance, Type "98" Chrome Oil Rings provide maximum oil drainage! Perfect Circle Corporation, Hagerstown, Indiana; The Perfect Circle Co., Ltd., 888 Don Mills Road, Don Mills, Ontario.

U. S. patents 2,635,022 and 2,695,825

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PISTON RINGS

Preferred by more people than any other brand!

SAE Journal

Pub. Off.: 10 McGovern Ave., Lancaster, Pa.
Ed. Off.: 485 Lexington Ave., New York, N.Y.

Contents · October 1957

(Continued on page 2)

To order complete papers on which articles are based, turn to page 5.

SAE Journal

Contents • October 1957 • Continued

The SAE Story for October

To order complete papers on which articles are based, turn to page 5.

SAE JOURNAL, October, 1957, Vol. 65, No. 11. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 485 Lexington Ave., New York 17, N. Y. $1 per number; $10 per year; foreign $12 per year; to members 50¢ per number, $5 per year. Entered as second class matter, Sept. 15, 1948, at the Post Office at Lancaster, Pa., under the act of Aug. 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of Feb. 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1918. Additional entry at New York N. Y.

The unique design of the "load cushion" accounts for smooth, even rides in the full range of loads, empty to full. Enjay Butyl Rubber (in red) made it possible.

ENJAY BUTYL "LOAD CUSHION"

replaces steel springs in big Tractor Trailers

The "load cushion" is an important innovation in tandem suspension. Developed by the Hendrickson Mfg. Company, it is made of Enjay Butyl and replaces steel leaf springs. Utilizing the great strength and impact resistance of Enjay Butyl, the "load cushion" gives the ultimate in a soft, easy ride within the complete range of loading, from empty to full. Besides giving a smoother, steadier ride, it increases tire mileage, reduces weight and significantly reduces wear and tear on equipment.

Enjay Butyl has proved to be the answer to problems in many fields of industry. It may well be able to cut costs and improve the performance of *your* product. Low-priced and immediately available, Enjay Butyl may be obtained in non-staining grades for white and light-colored applications. Get all the facts by contacting the Enjay Company. Complete laboratory facilities and technical assistance are at your service.

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AIRCRAFT

Developments in Air Defense, K. H. GIBSON. Paper No. S1. Presented Feb., 1957 (Southern Calif. Section), 10 p. Mission of defensive mechanism of U. S. Air Force is active air defense comprising all measures aimed at destroying or threatening destruction of hostile aircraft and their crews in air; Soviet Union's intentions and capability; various types of Russian carriers, such as TU-4, 4-jet bomber Bison, Soviet Badger, etc. compared to American carriers; mission and operations of "Conad" (Continental air defense command).

Thrust Reversers for Jet Aircraft, F. J. STIMLER, J. F. McDERMOTT. Paper No. 112. Presented Apr., 1957, 21 p. Results of U. S. Air Force Programs conducted at Goodyear Corp. illustrate advances made during past two yr; programs involved design, fabrication and testing of prototypes for F-86D and F-86E aircraft utilizing J47-17 and J47-13 engines respectively; three basic types are: full-blockage, tailpipe cascade type, partial blockage cascade, and target type; design considerations.

Overrun Safety Arrestment of Commercial Jet Aircraft, C. J. DANIELS. Paper No. 114. Presented Apr., 1957, 14 p. Development of arresting engine by All Engineering Co. especially for use on runways; arresting cable is attached to piston which fits loosely inside water filled tube; when aircraft engages cable it tows piston through tube and hydraulic drag of piston arrests plane; aircraft weighing from 100,000 to 300,000 lb can be arrested from engaging speeds of 0 to 120 knots.

Research and Development Through Uninhibited Thinking, G. W. HOOVER. Paper No. S19. Presented Jan., 1957 (Philadelphia Section), 6 p. Weaknesses of present system of research and development are pointed out and place and role of each group defined; it is shown how to apply scientific approach to problem of aircraft instrumentation in five areas of overall problem, namely: display, sensing, computation, control, and communication; establishment of information and display requirements; problems of sensors and computation.

Design Philosophy of Short to Medium Range Turbojet Transport, A. D. RIEDLER. Paper No. S3. Presented May, 1957 (Metropolitan Section), 8 p. Method of designing successful turbojet transport in agreement with design objective of transport aircraft; public's requirement and productivity of aircraft; how it was possible to obtain direct operating costs on Convair 800 turbojet transport comparable to those of propellered aircraft at ranges where increased cruise speeds are fully effective in increasing block speed.

Air Force's Weapons Systems Concept, D. H. BAKER. Paper No. S4. Mar., 1957 (Texas Section), 6 p. Reasons behind current Air Force policy; complete weapons system policy itself and way in which it has worked over past few years; impact of electronics, development and production of guided missiles and increased complexity of weapons on weapons system policy: Air Force's management job of linking and integrating separate technical efforts into unified systems.

Forward Look at Air Traffic Control, L. E. WARREN. Paper No. S5. Presented Feb., 1957 (Metropolitan Section), 11 p. Responsibilities of CAA in constructing, operating and maintaining air traffic control system; scope of operations handled by ATC center and problems associated with operations; CAA implementation program for future, covered in Federal Airway Plan which projects requirements in ad-

Continued on page 6

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Briefs of SAE PAPERS

Continued from page 5

vance; research and development effort under way.

FUELS

Restrictive Specifications Will Increase Jet Fuel Costs, H. R. PORTER, G. D. GOULD, M. L. WOLDEN. Paper No. S 6. Presented Jan., 1957 (Southern California Section), 12 p. Paper, prepared by Standard Oil Co., examines restrictive specifications on fuel properties and how they will affect commercial jet fuel availability and costs; kerosene type jet fuels and critical properties are discussed; examples on how to evaluate effect of variations of flash point, sulphur content, smoke and freezing point; tables, curves.

Vapor Locking Tendencies of Fuels —Practical Approach, J. D. CAPLAN, C. J. BRADY. Paper No. 141. Presented June, 1957, 17 p. Practical method of measuring and expressing vapor locking tendencies of gasolines, developed by General Motors Corp. and designated GMVP (General Motors Vapor Pressure) utilizes modification of Reid Vapor Pressure Apparatus; modifications of bomb and bath; summary of results of comparison of vapor locking tendencies of gasolines.

Combustion Chamber Deposits—Radiotracer Study, L. B. SHORE, K. F. OCKERT. Paper No. 145. Presented June, 1957, 25 p. Results of engine tests, undertaken by Esso Research & Engineering Co., using C^{14} labeled hydrocarbons to determine deposit forming tendency of various hydrocarbon components of gasoline; experimental technique and its advantages; implications and conclusions drawn.

Some Factors Affecting Unburned Hydrocarbons in Combustion Products, J. N. SHINN. Paper No. 146. Presented June, 1957, 17 p. Investigation of factors causing unburned hydrocarbons contained in exhaust gases emitted from automobile engines; preliminary engine test results, design of combustion apparatus, and its operation; methods of exhaust gas analysis; combustion apparatus results; evidence presented indicates that majority of hydrocarbons appearing are associated with phenomena occurring at combustion chamber walls; tables.

GROUND VEHICLES

Road Behavior of Modern Truck, A. C. MAIR. Paper No. 121. Presented June, 1957, 18 p. "Handling" of truck is associated with vehicle's lateral motions of roll, yaw and sideslip, excited by applied forces i.e., caused by changes in direction of vehicle; tire properties and effect of side forces; effect of slip angle and cornering force; truck behavior characteristics and steer effect from tire properties; dynamic tire loading; suggestions made to truck and tire designers.

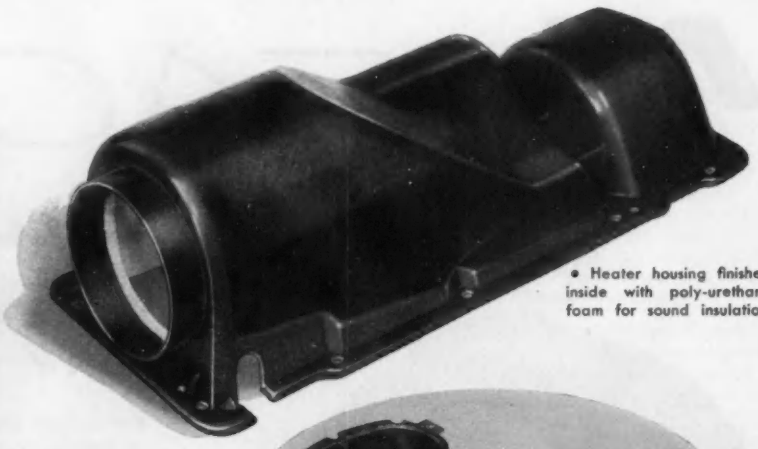
Possibilities of Spare Tire Elimination, P. W. DREW. Paper No. 122. Presented June, 1957, 11 p. 2-Compartment "keep going" captive-air safety tire consists of standard nylon tire with continuous inner liner and safety shield of two rubberized plies of nylon dividing tire into two independent pressure compartments: construction of new type of compression sealed sidewall valve; tire performance tests; improvement through Ny-Wire breaker safety shield; future trends.

Low Profile Passenger Car Tires, J. G. BERRY. Paper No. 123. Presented June, 1957, 11 p. Basic Criteria in designing low profile tires referring to shape of tire section having ratio of section height to section width less than unity; dimensional comparison of low profile tires and results of ride checks; future trends.

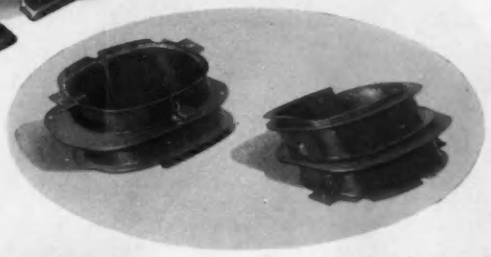
Method of Measuring Thump and Roughness for Quality Control of Passenger Car Tire Production, F. HERZEGH. Paper No. 124. Presented June, 1957, 24 p. Simple, accurate thump detecting device, developed by B. F. Goodrich Co., to measure degree of magnitude of thump as indicated by physical effects such as strain, stress, acceleration, velocity and displacement,

Continued on page 110

• Car air conditioning ducts covered with poly-urethane foam for thermal insulation.



• Heater housing finished inside with poly-urethane foam for sound insulation.



• Reinforced plastic shrouds for car side air duct outlets.

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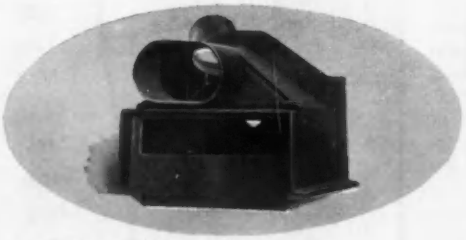
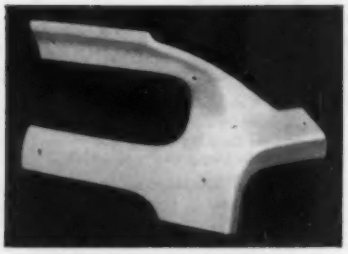
• Heater blower housing.



• Housing for air conditioning system.



• Exterior trim molding ready to be finished with a decorative simulated wood grain pattern.

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Intricate, complex parts are difficult to design and costly to make out of metals. That's why more and more design and production engineers are turning to Fabricon reinforced plastic moldings for the answers to their problems. For component parts like those shown here can be quickly, easily produced with relatively inexpensive tooling . . . formed at once into finished pieces that require no costly secondary operations. What's more, they are made of special custom premix compounds developed by Fabricon after years of working with all types of resins and fiber reinforcements. And they are processed by modern laboratory controlled molding techniques which assure consistent uniformity of quality plus the best possible combination of the physical properties required for each individual application.

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by Goodyear

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One big reason is the development by Goodyear of the Tru-Seal Rim. This is the rim that has been adopted as standard by the Tire and Rim Association for tubeless replacement of all conventional tire sizes 12:00 and larger.

Tru-Seal is the only practical method yet devised to seal a multiple-piece rim. It adds one more to the many benefits Goodyear's vast tire-building experience brings to rim construction. With Goodyear rims, you profit by such advantages as:

Unusual Strength: Thanks to an exclusive double-welding process, and added support at points of greatest stress, present-day Goodyear Rims are far stronger than previous rims.

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Special Tools: Goodyear alone provides both hydraulic and hand tools especially made for larger wheel sizes.

Bond-a-Coat Finish: This protective coating affords long-lasting resistance to rust and corrosion.

If you have a rim problem, why not talk it over with the G.R.E. (Goodyear Rim Engineer). He'll save you time and money by helping you select the type and size of rim best suited to your needs. Write him at Goodyear, Metal Products Division, Akron 16, Ohio, or contact your local Goodyear Rim Distributor.

New Tru-Seal Rims – for sizes 12:00 and up, including all earth-mover and grader sizes. This rim is similar to multiple-piece rims now in use—PLUS airtight Tru-Seal rubber ring which compresses into sealing groove when tire is mounted.

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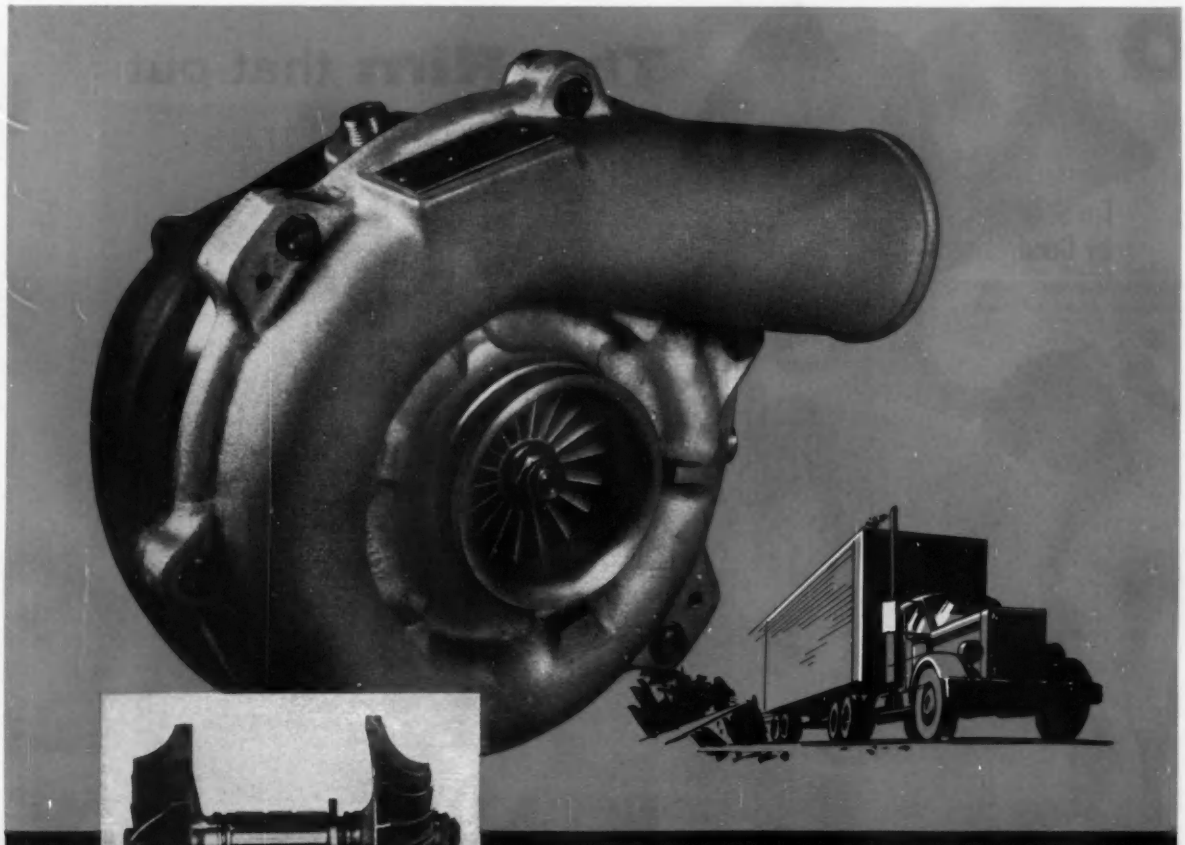
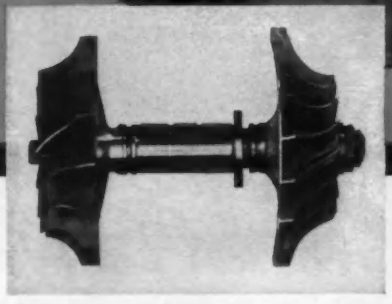
MORE TONS ARE CARRIED ON GOODYEAR RIMS THAN ON ANY OTHER KIND

Tru-Seal—T.M. The Goodyear Tire & Rubber Company, Akron, Ohio





NEW! Simpler Design Makes Thompson Turbochargers Easier to Service

Careful location of simple, one-piece bearing in Thompson Turbochargers has resulted in high critical speeds at smaller shaft diameters. This means lower bearing surface speeds at equal compression ratios . . . greatly increased bearing life.

In addition, every precaution has been taken to prevent turbine heat from reaching the bearing area. Turbine shields, swept by compressor discharge air, effectively reduce heat transfer to the bearing housing.

Throughout new Thompson Turbochargers you'll find many other important design features. Advanced design impeller gives you highest efficiency over a wider range of operation . . . simple, lightweight impeller and turbine respond instantly to speed and load changes.

With all of these advantages, new Thompson Turbochargers can be custom-matched to your diesel engine models up to 300 horsepower. Our engineers are available to work with you.

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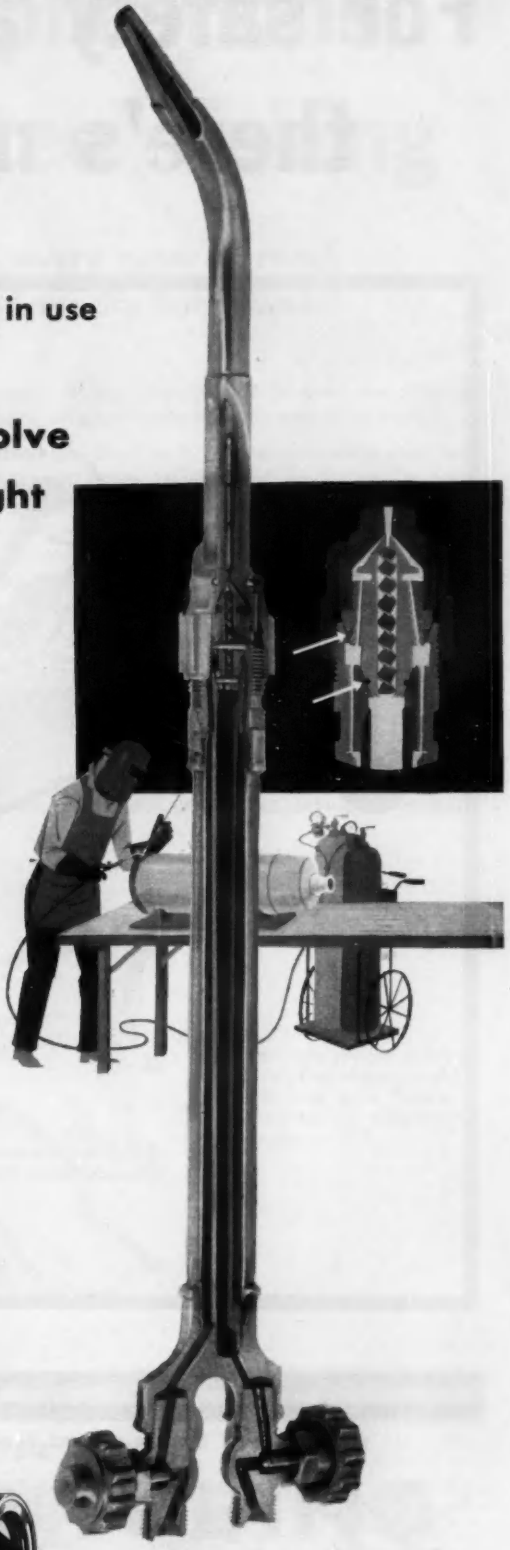
Ozone deterioration

Continuing stress

Gas leakage

Rough handling in use

New National Hypalon O-rings solve these problems; insure a hand-tight gas seal in Victor Torches



As static seals, commercial Buna N O-rings performed satisfactorily in Victor welding torches — *when the rings were new.*

However, ordinary O-rings age fast in welding torches. They receive rough treatment when welders change nozzles; nozzles are often dropped on the ground to lie there until needed again. Severe ozone deterioration is experienced. Continuing stress, although mild, impairs O-ring elasticity. Rings on welding nozzles are sometimes subjected to long shelf life.

National Seal engineers developed a new O-ring compound, National Hypalon L-11, which not only withstands rough handling, ozone deterioration and stress but exhibits many times the shelf life of Buna N compounds previously used. Today, National Hypalon is standard at Victor.

Special compounding to meet unusual conditions is a basic part of National's complete O-ring engineering service — service available from National Field Engineers in major cities nationwide.

NATIONAL SEAL
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Plants: Van Wert, Ohio, Redwood City and Downey, California

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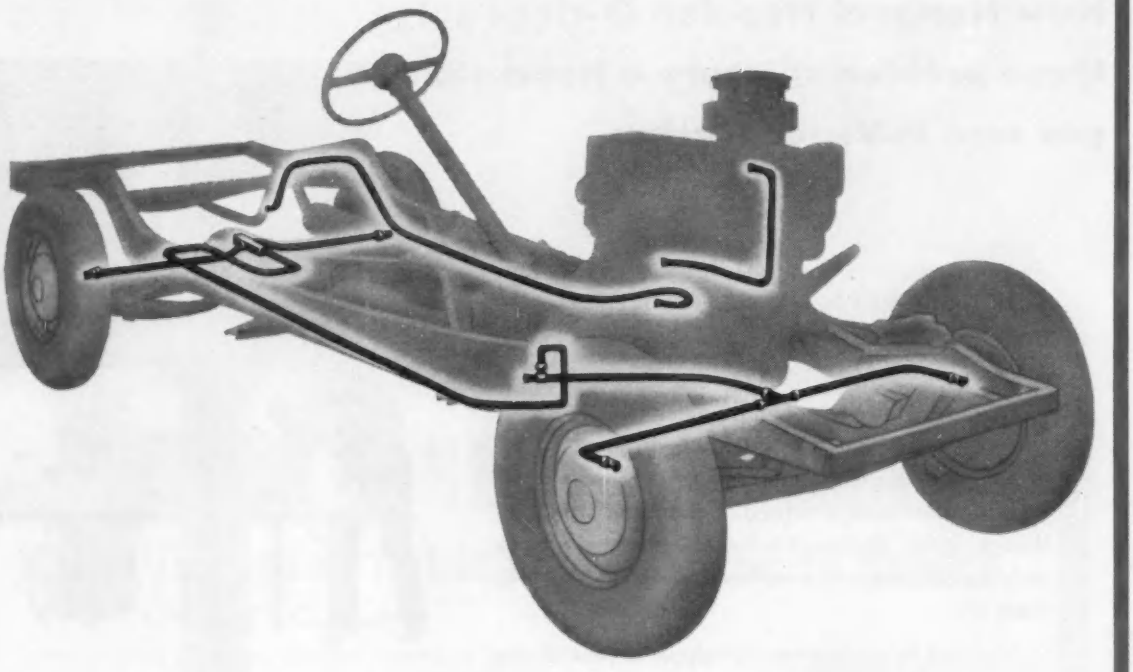

For dependable fuel, oil and hydraulic brake lines, automotive engineers know that *only* Bundyweld Steel Tubing will do.

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Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

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in automotive applications, for Bundyweld Steel Tubing

Proved by billions of miles over every type of road: you get more than tubing when you specify Bundyweld!

When you specify tubing for brake lines (or other automotive applications), it pays to look beyond cost-per-foot alone. Just consider what *else* you get with Bundyweld® Tubing.

You get safety, proved in the billion-mile operation of cars, trucks, tractors and buses all over the world. In the last 25 years, over two billion feet of Bundyweld Tubing have been used for tubing parts on these vehicles in every price class.

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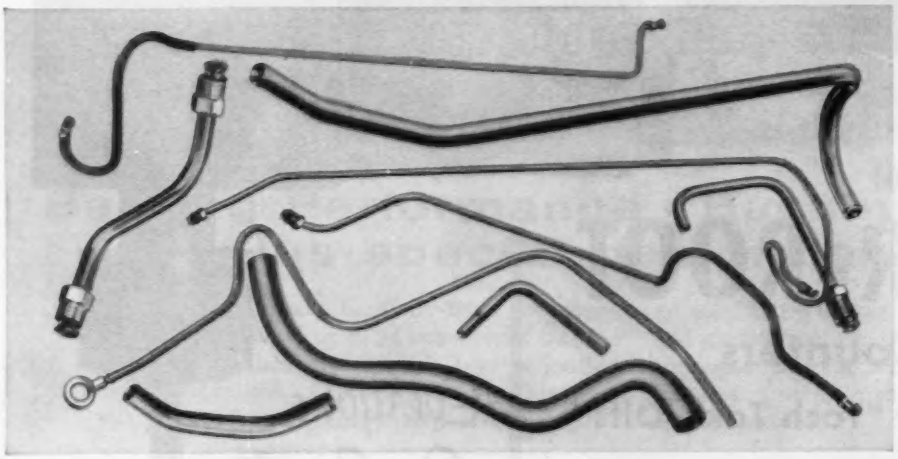

Shown here are but a few of the countless shapes in which Bundyweld Steel Tubing is fabricated for automotive applications.

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Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

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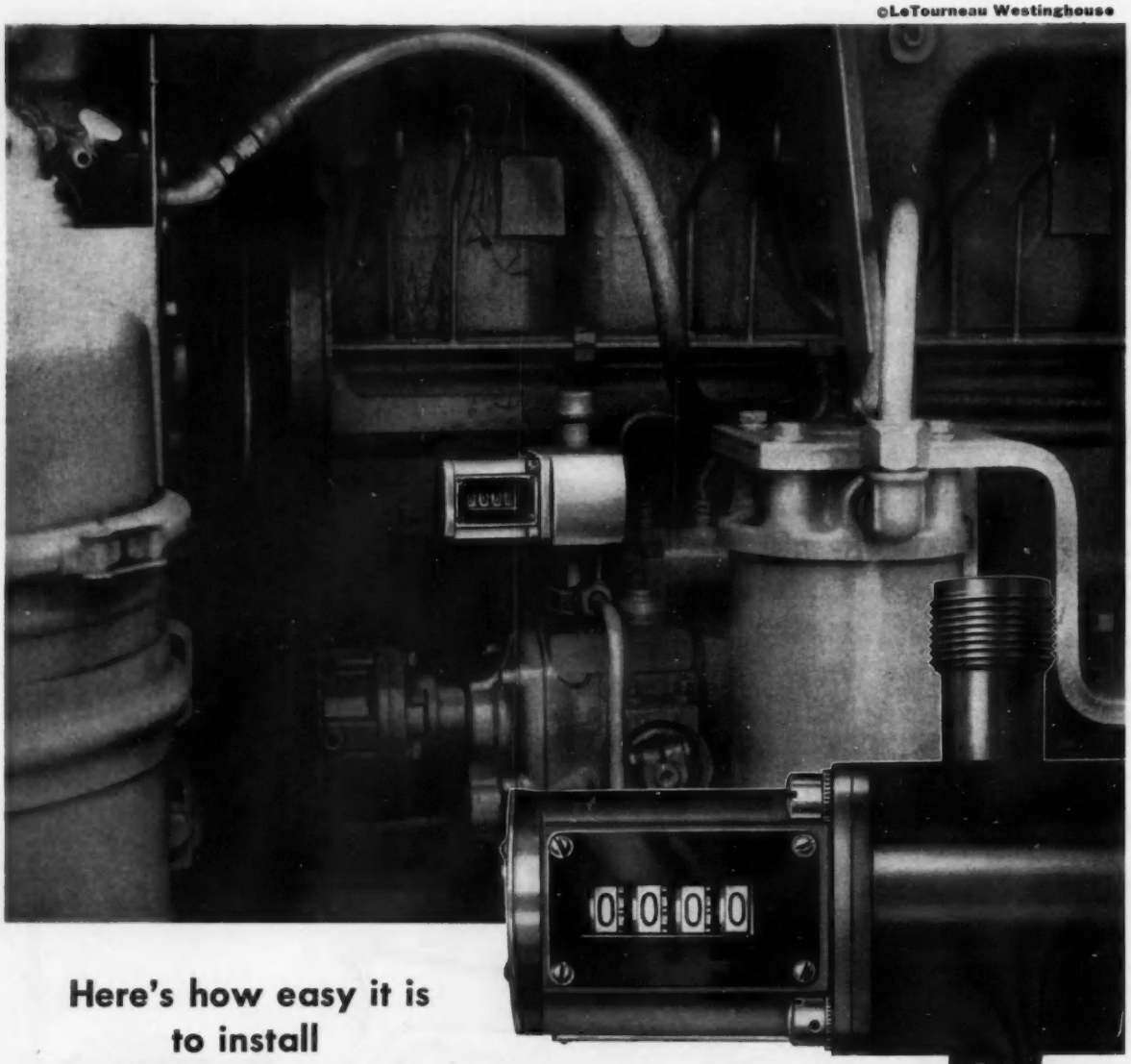

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On any engine having a tachometer take-off, Veeder-Root Rev-Counters can be installed in a position which is readily accessible for easy reading . . . so the man who reads the counter doesn't get all messed up or get a crick in his neck.

In fact, with these new attachments, Veeder-Root Rev-Counters make it easy for anyone to see how your equipment is living up to its guarantee . . . when routine maintenance is coming due . . . and to get other valuable facts-in-figures.

You can count on Veeder-Root to help you engineer these adaptable counters not only into engines, but into generators, compressors, heaters, and other equipment. And you will find . . . as other manufacturers of power-units have found . . . that when you build in Veeder-Root Counters, *you build up sales.*

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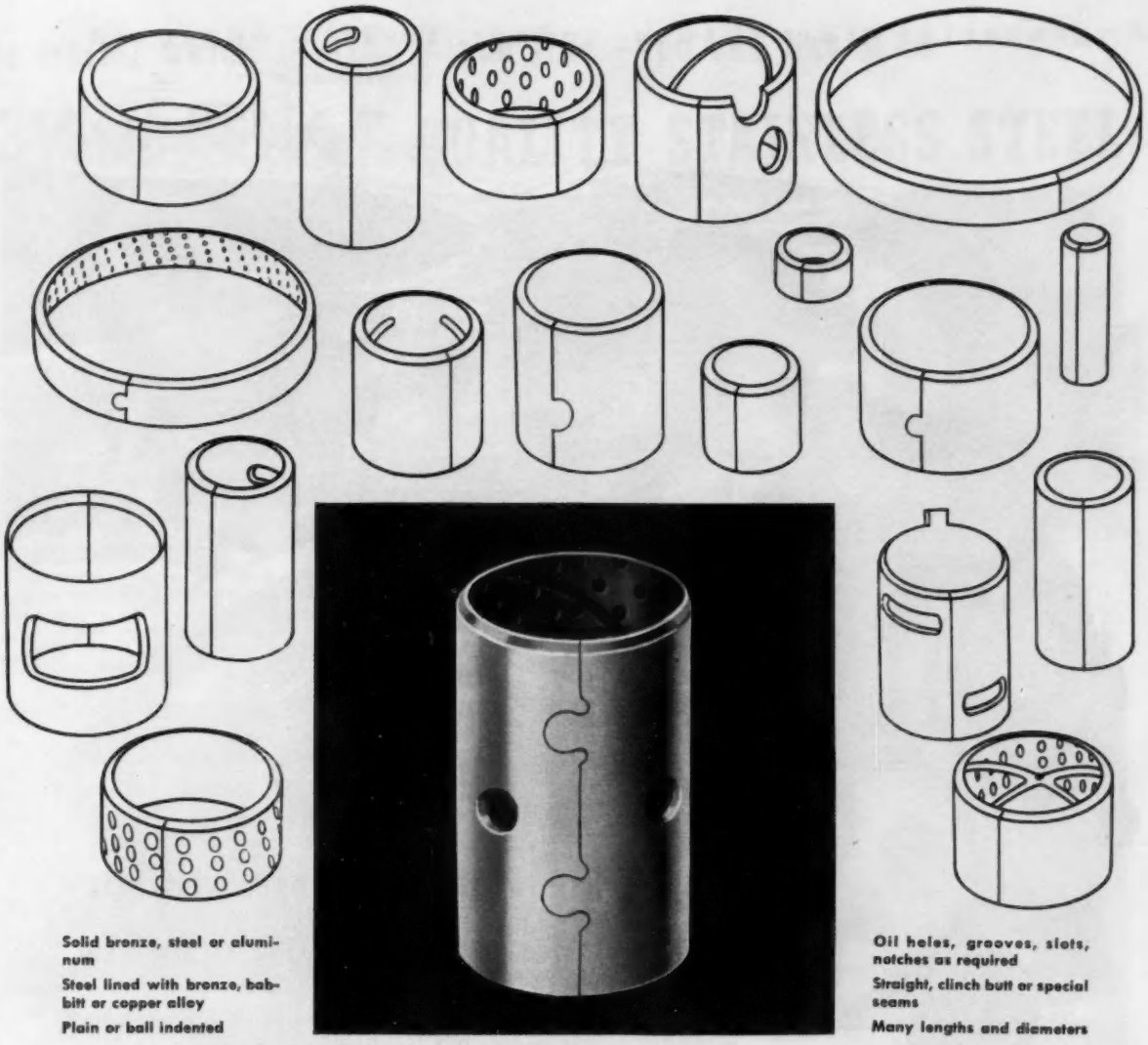

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Savings in materials, time and labor are possible using bimetal or plain rolled split bushings. Bimetal bushings provide bearing load-carrying qualities. All offer economy through volume production. Uniformity and strength are established through controlled alloy quality and grain structure. Our method of manufacture also permits wide flexibility in design features. Complete engineering service. For details, address:

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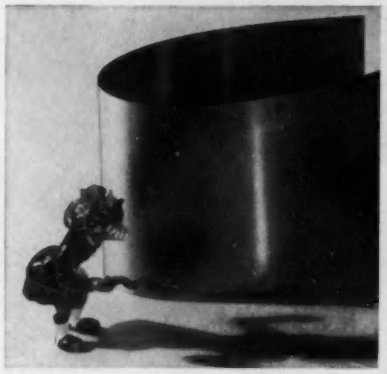
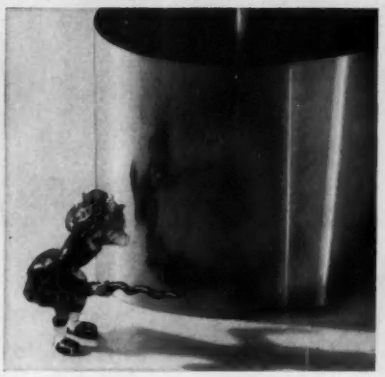


2D—A silvery white, but non-lustrous, surface produced by annealing and pickling cold reduced material. Steel sheets & strip in this condition are most ductile and the surface holds lubricant well for severe drawing operations.

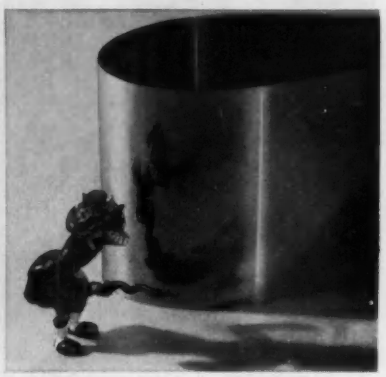
2B—Steel in the 2D condition which is subsequently rolled on a "skin pass" or temper mill. The surface acquires a bright finish from the polished rolls. This surface is somewhat more dense and hard than 2D and is a better starting surface for later finishing and buffing operations.

No. 3—This surface is made by grinding with a No. 100 abrasive. This surface is smooth but not as reflective as 2B.

No. 4—A finer finish than No. 3 made by grinding with a No. 150 abrasive. Like No. 3, this surface is easily blended with hand grinders after forming, drawing or welding.



No. 7—Good reflectivity and brilliance made by polishing with a No. 400 abrasive. This semi-mirror finish must be protected during fabrication by adhesive paper or strippable plastics lest the finish be marred beyond repair.



BRIGHT—A highly reflective surface made by cold reducing with highly polished, glass-hard rolls. This finish is only available in Type 430 stainless.

These are our standard surface finishes that are available in types 201, 202, 301, 302, 304 and 430 except Bright which is type 430 exclusively.

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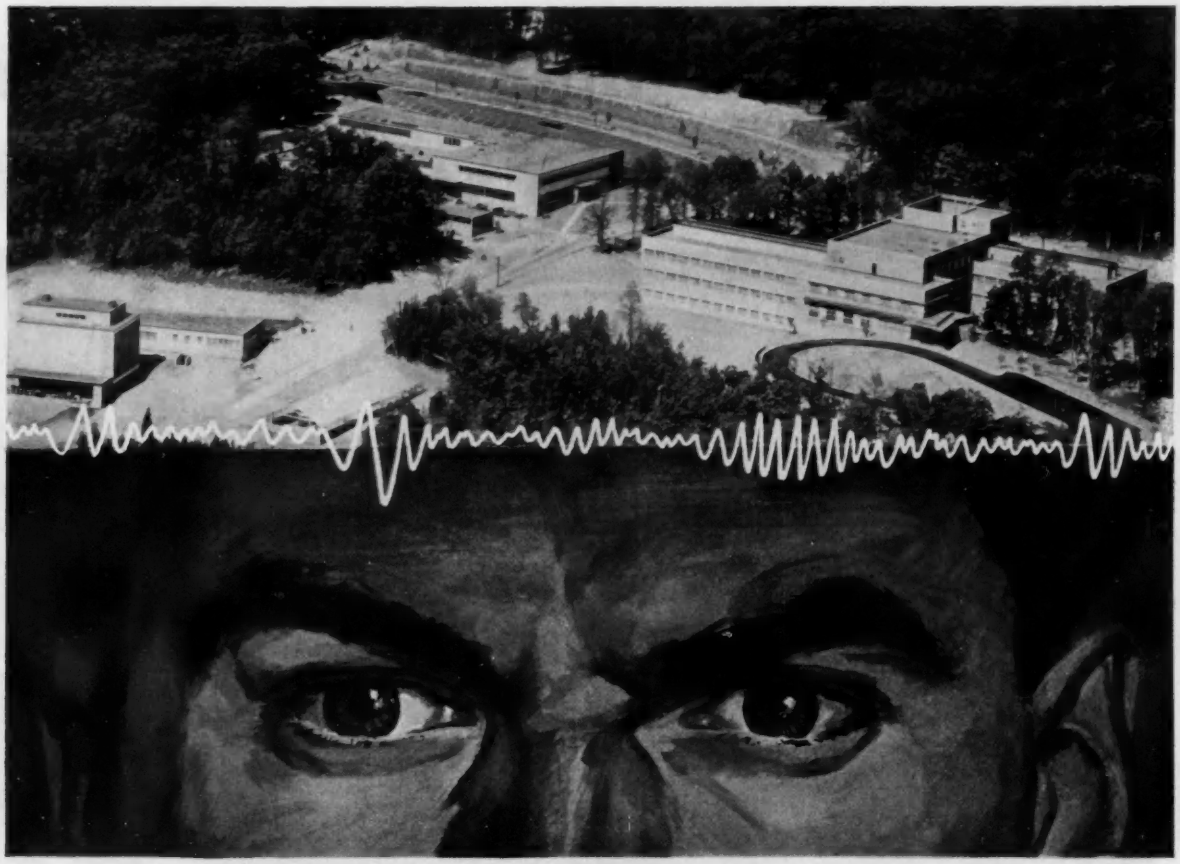

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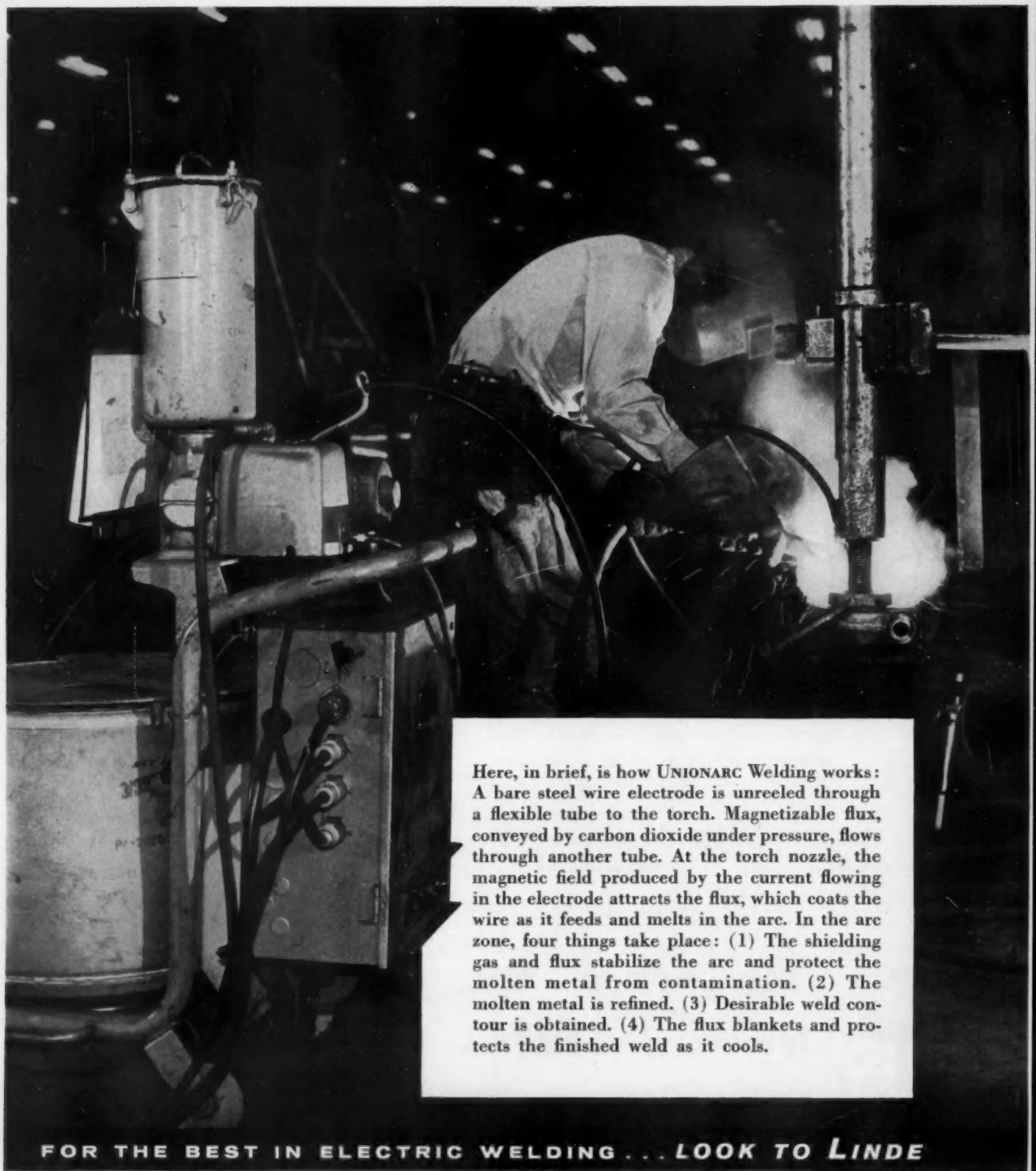

Here, in brief, is how UNIONARC Welding works: A bare steel wire electrode is unreeled through a flexible tube to the torch. Magnetizable flux, conveyed by carbon dioxide under pressure, flows through another tube. At the torch nozzle, the magnetic field produced by the current flowing in the electrode attracts the flux, which coats the wire as it feeds and melts in the arc. In the arc zone, four things take place: (1) The shielding gas and flux stabilize the arc and protect the molten metal from contamination. (2) The molten metal is refined. (3) Desirable weld contour is obtained. (4) The flux blankets and protects the finished weld as it cools.

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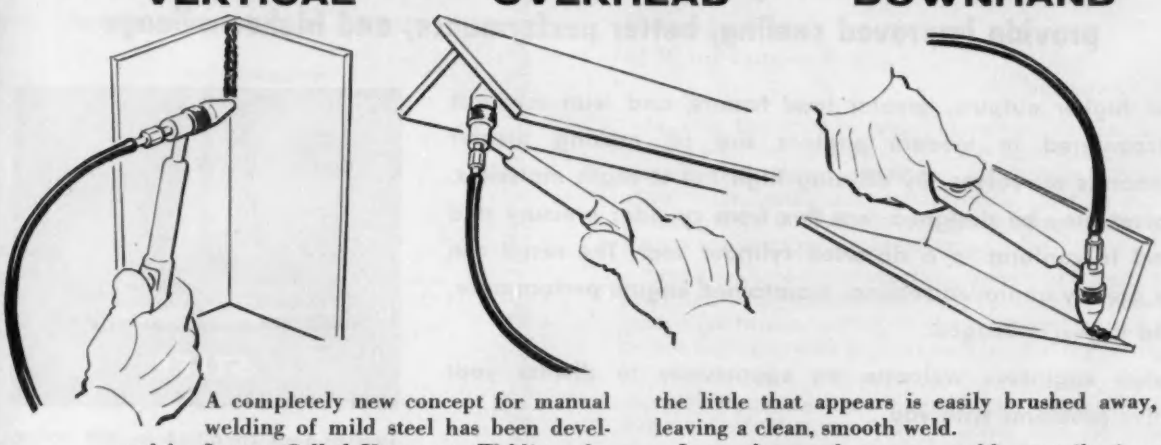

A completely new concept for manual welding of mild steel has been developed by LINDE. Called UNIONARC Welding, the method uses a continuously-fed bare steel wire electrode, which is magnetically coated with flux and shielded by carbon dioxide. The torch can be easily handled in all welding positions—vertical, overhead, downhand. Manual welds can be made at higher speeds and at lower cost than with covered electrodes. UNIONARC Welding produces high-quality welds in steel, even when moderate amounts of rust, scale, and moisture are present.

Among the numerous advantages of UNIONARC Welding are these: Rate of operation is up to three times faster than with covered electrodes. There is no stopping to renew electrodes, since a single loading of wire can be fed smoothly and continuously for periods up to a week. Manual skill needed is no more than that required with covered electrodes. In vertical and overhead positions, the deposition rate in UNIONARC Welding is two to three times greater than with covered electrode methods; in downhand positions, up to twice as great. There is practically no spatter—the little that appears is easily brushed away, leaving a clean, smooth weld.

LINDE has made many notable contributions to welding. Among these are the introduction and development of submerged arc welding (UNIONMELT Welding), non-consumable electrode, inert gas shielded arc welding (HELIARC Welding), and the development of Sigma (shielded inert gas metal arc) welding. LINDE's newest method, UNIONARC Welding, is another *first*—a truly important contribution. Its simplicity and versatility make it unique. Its efficiency and economy have been proved in actual production work. Write *now* for details about UNIONARC Welding, or call the LINDE office nearest you.

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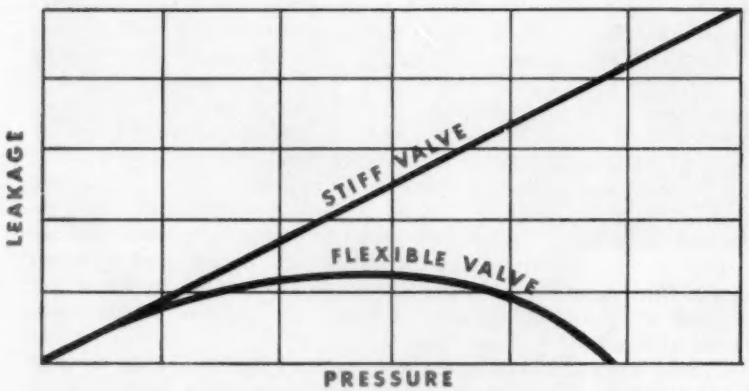

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For the Sake of Argument

Make the Most of What You've Got . . .

By Norman G. Shidle

Making the most of what you've got is the shortest distance to useful results . . . just as a straight line is the shortest distance between two points. There are other ways; sometimes better ones. But to insist on finding them before moving often delays rather than speeds satisfactory achievement.

Asked to increase production, some think first: "We'll need new equipment, more floor space, and more competent operators." They inject a suggestion for delay, before taking even a mental step toward higher output.

Other minds ask themselves immediately: "Can't we start by changing what we're doing? How can we get more out of what we have." Their first thought has already started toward more production.

Same thing is true of personal qualities, once school days are left behind. First step in problem-solving may well be to marshal existing abilities and mental resources; to try for as good a solution as they will bring. Those abilities and resources can actually grow in the process of being exercised; more faster and further next time.

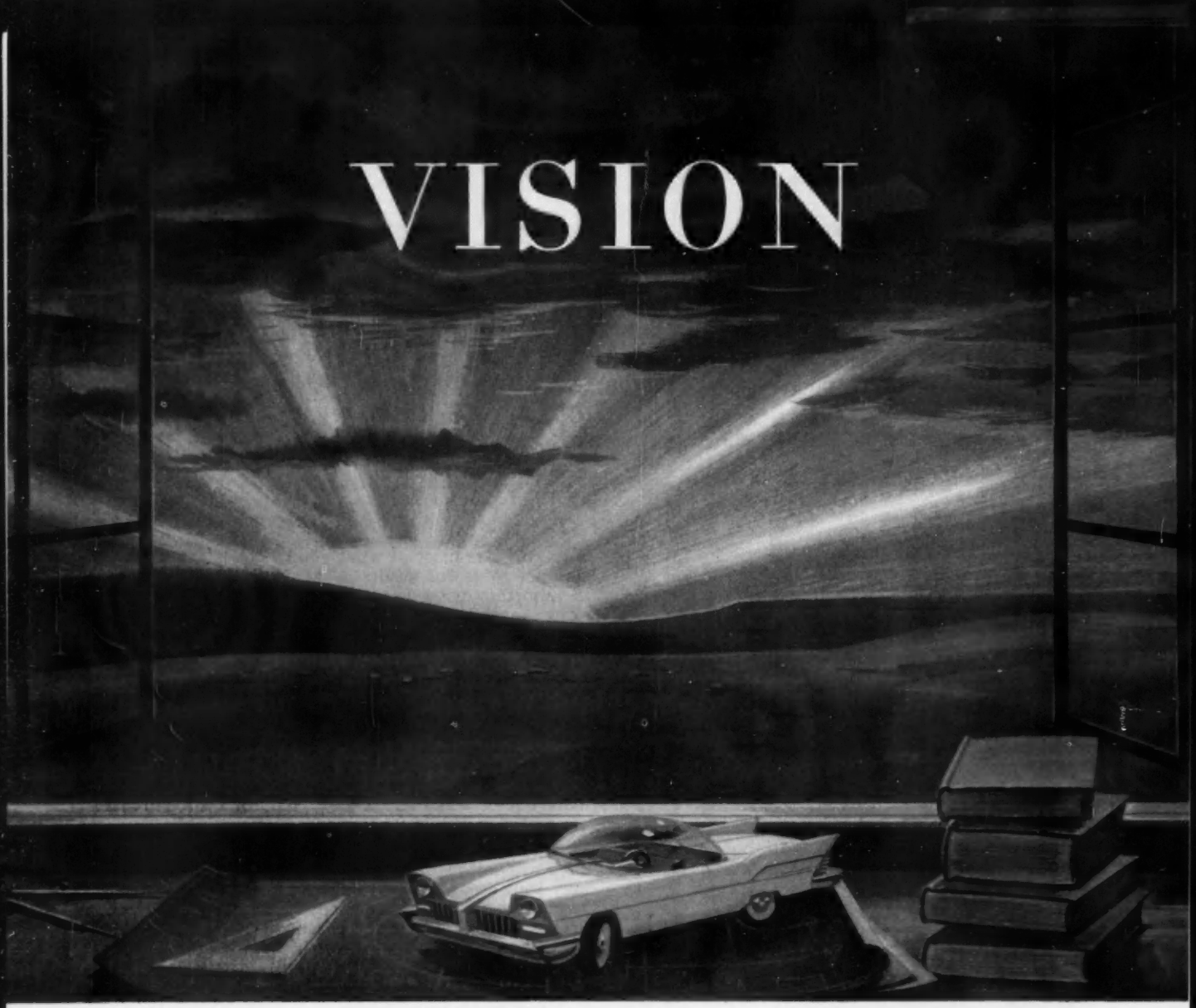
"Develop to the highest degree possible, the qualities and talents which you naturally enjoy using. Settle for bringing to "satisfactory" levels, those talents which come hard. . . . You won't have time for both." That advice, we heard a guidance counsellor give a young engineer a while back.

"A mediocre plan, executed effectively, brings better results than a brilliant plan poorly executed," Harry Tipper used to emphasize to young subordinates. By the same token, natural talents—which tend to apply smoothly—may get better results than use of talents which come hard . . . and apply awkwardly.

We fail most frequently when we seek a goal by someone else's path. We stumble most trying to walk the other fellow's way; get best results, when we do the best *we* can.

"Making the most of what you have" is not the worst definition of success.

VISION



LOOKING TO THE FUTURE—PRODUCING FOR TODAY!

Progress has been the keynote of the automotive industry. Today's achievements are but challenges for the accomplishments of tomorrow.

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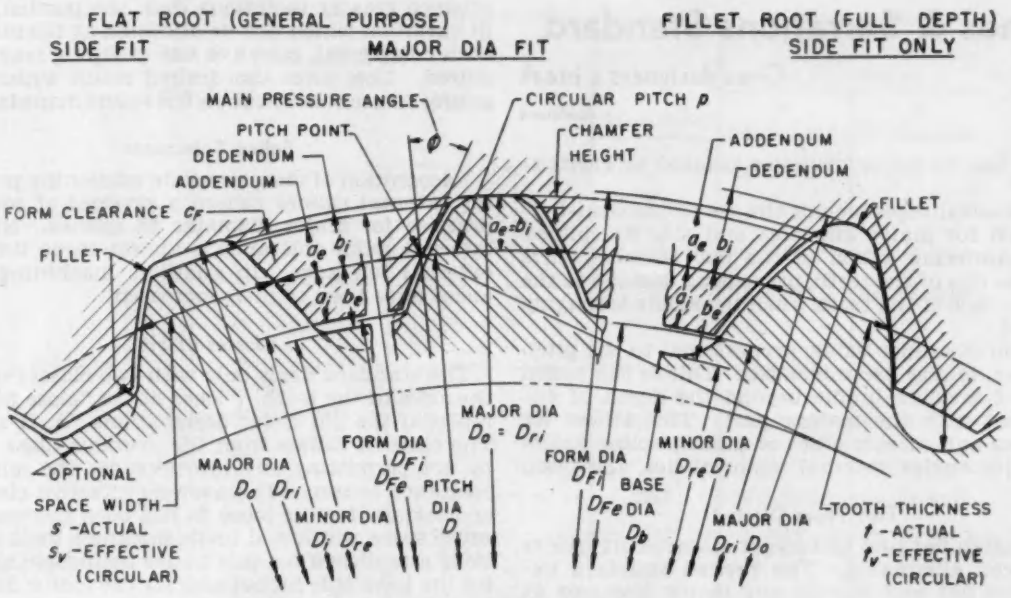

Fig. 1—Three types of spline fit are individually tabulated in new SAE standard.

New Splines & Serrations Standard

Gives designers a break

Nine major revisions simplify the standard and separate the types of spline fit.

Based on report by

Albert S. Beam

Staff Engineer, Vinco Corp.

SIMPLE and effective usage is the keynote of SAE's new simple and serration standard. The designer has been considered first. Spline, serration, and inspection data have been put into a form that pinpoints application rather than tooling problems. (The new standard appears in the 1957 SAE Handbook.)

Major changes include reducing the number of spline fits and types to five. Serrations are of one type and fit. The three types of splines are shown in Fig. 1 as flat-root side fit, flat-root major-diameter fit, and fillet-root side fit. Tabular information is separated for each type, so the designer doesn't have to "research" complicated tables.

Splines Change Dimensions

Splines made according to the new standard are interchangeable with all types of splines from the old standard, with the exception of external splines designed to mate with the old full dedendum flat root internal splines which have been abandoned. The full dedendum design was originally created to provide more clearance and tolerance for the generating action of the shaper cutters. But it resulted in longer and more costly broaches for flat root major diameter fit splines. The new dedendum height is equal to the previous short dedendum design and the present major diameter fit dedendum. The distinction between the side- and major-diameter fits is made in the major diameter of the external spline and by allowing more tolerance on the major-diameter of side fit splines. Under this setup, old broaches can be used if the full dedendum

New Splines & Serrations Standard

Gives designers a break

continued

broach has its major diameter reduced by regrinding.

Other advantages include the use of one semi-topping hob for major diameter and side fit splines. The chamfering action of the hob removes burrs from the tips of the teeth, preventing damage to the involute face of the tooth when the spline is roughly handled.

A form clearance value, proportional to the pitch diameter, is now recommended. This is the radial depth of involute profile beyond the depth of engagement with the mating part. This allows for looseness and eccentricities of mating spline external major circles, internal minor circles, and pitch circles.

Two Types Deleted

Fine pitch flat root and major diameter fit splines have been eliminated. The revised standard extends the flat root side fit and major diameter fit splines from the coarsest up to 32/64 pitch. The flat root design is discontinued for 40/80 and 48/96 pitch because the width of the land at the root of the internal member would be less than 0.015 if allowance is made for the root fillet. Experience indicates that the flat root design is used rarely for these fine pitches. Where a major diameter fit with short depth is desired, a special design has been suggested which would use fine pitch depth proportions, but increase the circular pitch by, for instance, 100%. Such splines may be designated, for example, as special 20/80 pitch splines and would require special tooling. They would have sufficient land at the root of the internal member to enable the use of major diameter fits where shallow depth would otherwise lead to impractical proportions.

Minor Diameter Fit Abandoned

Minor diameter fits are no longer presented. This type of fit has been used in the past on straight sided splines to provide fit areas which can be used to maintain concentric location. However, the machining of the lands at the minor diameter of the external spline within close limits is difficult. So, this type of fit has given way to the major diameter fit. Much better control can be maintained by broaching the major diameter of the internal spline simultaneously with its teeth and grinding the major diameter of the external spline.

Tabulations for Press Fits Omitted

Interference fits at the sides of the teeth and at the major diameter are not covered by the standard. This decision was made because press fits vary greatly in the degree of desired tightness. The final tolerance allocation depends on many factors, which cannot be covered in a standard; such factors include the shape of the blank, its wall thickness, the material of the components, their hardness, and thermal expansion. Frequently the range of fit variation which can be tolerated is so narrow that tolerances become very small. When manufacturing processes produce greater variations than the portion of the fit variation which can be allocated as tolerance for each component, selective size grouping may be required. This gives the desired result without imposing severe tolerances on the spline manufacturer.

Spline Tolerances

Recognition of more accurate machining practices for external splines caused a reversal of tolerance practice for major diameter fit splines. Now the internal spline tolerance is almost three times the external tolerance. In addition, machining tolerances have been slightly increased.

Classes of Fit

The standard deals only with two classes of fit at the sides of the teeth. "loose fit" or "close fit" have replaced the old letter designations "A, B and C". The close fit differs from the previous Class "B" fit by not permitting any interference; the minimum clearance is zero. The average effective clearance or backlash for the loose fit has been increased because space width and tooth thickness limit dimensions established for this fit are applicable not only for the loose side fit, but also for the major diameter fit. The increased looseness prevents the major diameter fit from inadvertently turning into a side fit. This could occur within the limits of the old standard, since the clearance between major diameters could be greater than the clearance at the tooth sides.

Simplification of Control Systems

Effective and actual space width as related to tooth thickness dimensions of mating components is shown in Fig. 2. In the standard system, the extreme dimensions of each part are specified as control limits. Their spread represents the sum of the machining tolerance and the error allowance. The alternate dimensioning method "A" adds the maximum effective space width and the minimum effective tooth thickness to the control limits of the standard system. It should be used when it is necessary to prevent the increase of maximum effective clearance C_v max. (maximum backlash). This would occur when the accumulation of errors is less than the assumed error allowance. This condition frequently occurs when broaching internal splines, because broaching errors are less than the errors based on generating processes.

The alternate dimensioning system "B" is used "where the effective error needs no control or is controlled by laboratory inspection." In this system, which is used primarily for instrument splines, only the effective space width and tooth thickness limits are employed as control limits.

To distinguish between the three dimensioning methods, the standard recommends the judicious placement of the notation "REF." to those dimensions which are not criteria for acceptance or rejection. This is in full agreement with the definition of reference dimensions in the SAE Automotive Drafting Standards.

Involute Serrations

Since experience shows that serrations are rarely

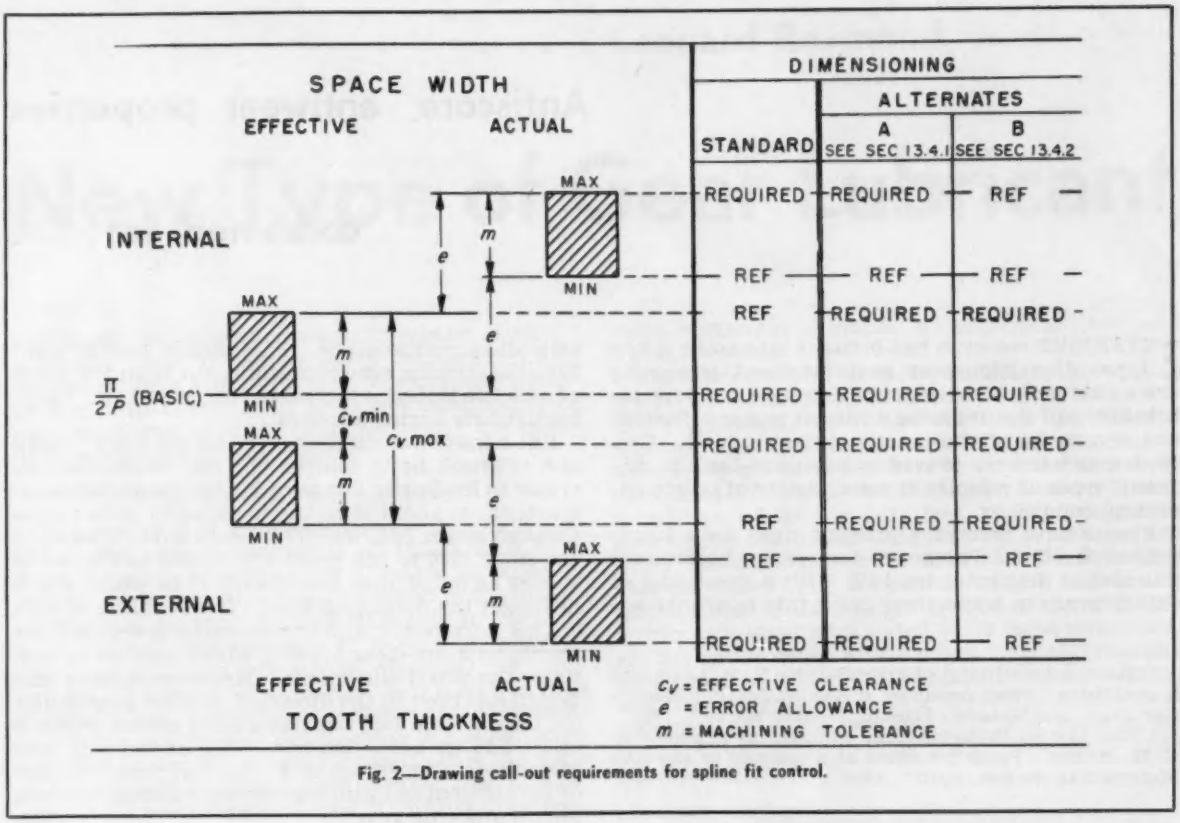

Fig. 2—Drawing call-out requirements for spline fit control.

used with loose fits, only one class of fit is shown in the revised Involute Serration Standard. Sliding fits are usually avoided because involute serrations have greater frictional resistance than involute splines due to their greater pressure angle. The omission of press fits from the standard reflects the difficulty of standardizing a type of fit the design of which is dependent on a great number of variables which cannot be anticipated by a standard.

While the basic dimensions of the revised Involute Serration Standard follow the pattern of the full fillet design, the standard specifically permits substitution of the flat root which should facilitate the manufacture of broaches for internal splines. The flat root substitution avoids the need of "capping" the broach teeth with a profile radius and allows the broach maker to circular grind the outside diameter of the broach.

Two control systems for the fit of involute serrations are presented in the revision. Each of these systems is given equal status.

For involute serrations which transmit light loads or for press fit applications, the effective space width and tooth thickness limits only are specified. In this case, the uniformity of the involute serration and the percentage of contact area between mating parts is of minor significance and, therefore, not subject to control. Actual space width and tooth thickness either are not specified or are treated as reference dimensions. This approach conforms to Alternate "B" of the Involute Spline Standard and is applicable to such components as levers for linkages, windshield wiper hubs, the steering gear Pitman arm.

For involute serrations which transmit more substantial loads or critical press fits, the extreme limits are given as control dimensions for each part which is the minimum effective and maximum actual space width for the internal, the maximum effective and minimum actual tooth thickness for the external spline. In these cases, it is necessary to control not only the machining tolerance, but also the effective error in order to maintain spline uniformity and a reasonable percentage of tooth contact area. This approach conforms to the standard system for involute splines and is used currently on automotive transmission input shafts, axles shafts, and pinion shafts.

To facilitate the use of either control system, the main tables for involute serrations list both limits for the effective space width and the effective tooth thickness, as well as the maximum actual space width and minimum actual tooth thickness. This listing should not be construed as requiring the specifications of all three dimensions for each part. Representative drawing data are included in the standard to illustrate the dimensioning for light loads and for heavier loads.

Although the work on inspection isn't completed, the "parts" sections and the finished portion of the inspection section have been released.

This report is the result of work by Technical Committee 13 on Splines and Spline Shafts of ASA Sectional Committee B5 on Small Tools and Machine Tool Elements.

Antiscore, antiwear properties combined in . . .

EXTENSIVE research has brought into being a new type of multipurpose gear lubricant possessing the antiscoring advantages of active-sulfur-type lubricants and the desirable antiwear and low-friction characteristics of the inactive-type products. Performance has been proved in extensive tests in different types of vehicles under a variety of severe operating conditions.

Events have created a pressing need for a lubricant of this type. Passenger-car average horsepower has almost doubled since 1950, with a great deal of this increase in horsepower going into midrange acceleration performance. This makes higher comfortable cruising speeds possible, but from the angle of axle life it means increased torque and axle loads, particularly during acceleration.

But horsepower climb is only half the story. Lewis and O'Brien[1] have pointed out the substantial increase in loading in low gear due to automatic transmissions, in addition to the increase in direct drive through larger engines. This loading on car axles in use since 1930 to the present is shown in Fig. 1. It should be noted that tractive effort or wheel slip is no longer the maximum load. The doubling of both engine horsepower and transmission low-gear ratio results in a low-gear loading which may be several times the wheel-slip torque. Moreover, hypoid axle design has been in the direction of more hypoid pinion offset. One 1957 car has a drive pinion which is offset 2.25 in. below the centerline of the ring gear compared to an offset of 1.5 in. last year. Higher offset automatically introduces more sliding between pinion and ring gear.

[1] "Rear Axles—Today—Tomorrow," by R. P. Lewis and L. J. O'Brien. Paper presented at SAE National Passenger-Car, Body, and Materials Meeting, Detroit, March 7, 1957.

[2] "Our Mutual Problems from Additives to Z zmog," by C. M. Heinen. Paper presented at a meeting of the SAE Metropolitan Section, April 7, 1955.

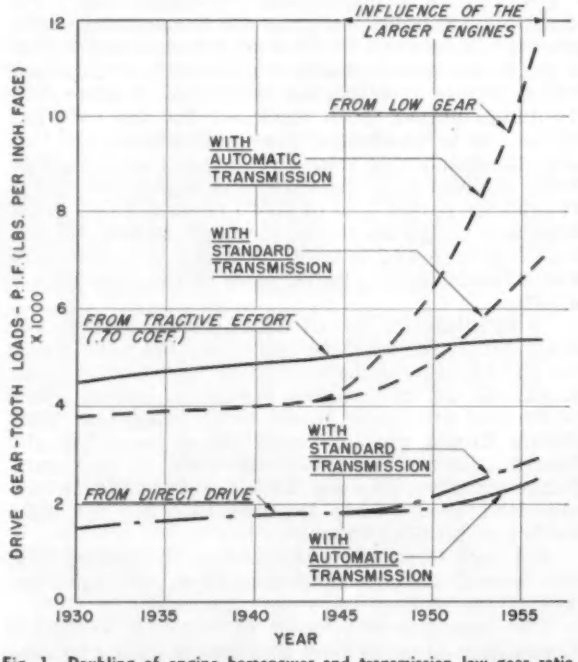

Fig. 1—Doubling of engine horsepower and transmission low-gear ratio has resulted in low-gear loading which may be several times the wheel-slip torque. Tractive effort or wheel slip is no longer the maximum load.

Trucks Parallel Passenger Cars

The axle problem is made even more difficult in trucks because of the ease of overloading a commercial vehicle. Heinen[2] has pointed out (Fig. 2) that pinion speeds of the truck axle at 55–60 mph are equivalent to those of a typical passenger car at 80 mph. Thus, the failures through scoring are similar at these speeds. The tremendous competition for more horsepower results in a greatly increased burden on the rear axle.

Antiscoring protection in passenger cars is not enough. Some car builders have found active-sulfur-type lubricants used as initial fill to be very effective in preventing metal-to-metal contact but deficient in protection against wear. This leads to looseness in antifriction bearings, loss of backlash, noisy axles, and other troubles. Moreover, while excelling in antiweld protection, the active-sulfur lubricants have unsatisfactory high-torque characteristics and, if used inadvertently in heavy-duty truck axles, may quickly destroy the gears through scoring and ridging, as shown in Fig. 3.

On the other hand, the inactive-type lubricant used for initial fill of commercial vehicle axles has proved unsatisfactory in some high-speed passenger-car tests, resulting in gear scoring and early axle failure. Also, since drive-pinion speeds of commercial vehicles are now in the range of high-speed passenger cars, despite the difference in vehicle speeds, the need for greater protection of truck axles against high-speed failures is obvious. This makes protection against scoring a recognized factor in the lubri-

Based on paper by **Leonard Raymond,** Socony Mobil Oil Co., Inc

New Type of Gear Lubricant

cation requirements of commercial vehicle axles.

Finally, tests in heavily laden military vehicles carried out over a period of several years show Specification MIL-L-2105 to be no longer adequate since even the better products procured under the specification resulted in axle trouble.

Properties of the New Lubricants

The new kind of multipurpose gear lubricant surpasses the axle requirements of MIL-L-2105 by a wide margin and represents a major advance in quality. It is a multipurpose lubricant in the broadest sense of the term through its ability to meet the most critical requirements of both high-powered passenger cars and commercial vehicles. By comparison, all other lubricants have only a limited field of application. It meets the requirements of passenger cars with "green" gears, being far superior in antiweld protection to any lubricant other than the single-purpose lead-soap, active-sulfur type, and far exceeds all previous truck-type lubricants in protection of heavy-duty truck axles.

The active elements in the new type of lubricant are sulfur, chlorine, and phosphorus, which act as potent antiweld materials under high temperature and pressure conditions by chemical formation of contaminating surface films which are strong in compression and weak in shear. Through controlled activity they supply the higher chemical activity needed quickly at high sliding velocities and pressures while retaining essential antiwear and high-torque protection characteristics. The chemical activity is controlled carefully to avoid undesirable corrosion, oxidation, and thermal-instability effects. When used in combination with stable base stocks, the result is controlled surface activity for maximum e-p effectiveness with adequate thermal and chemical stability and other desirable properties.

Product Performance

A gear lubricant performance chart of full-scale laboratory axle tests is shown in Fig. 4. The left side represents a performance scale of passenger-car axles, the right side for commercial vehicle axles, both in terms of increasing severity as indicated by the test designations appearing at the top.

The L-19 and L-20 tests fall far short of approaching the most severe conditions encountered with the modern car or truck. Qualification under current Ordnance Specification MIL-L-2105, which uses these two tests, does not, therefore, guarantee performance under the most severe service conditions. Indeed, some minimum quality MIL-L-2105 gear lubricants are extremely deficient in the light of today's maximum demands of passenger cars and trucks.

The inadequacy of the L-19 test has led some passenger car makers to use more severe tests like the Chevrolet "Bump Test" and the Buick "10-A Test." Similarly, the L-20 high-torque, low-speed test has been made much more severe in several Super-L-20 variations. The L-20 and the Super-L-20 tests have been replaced by the L-37 test, which combines a high-speed and a high-torque cycle in a single test which has given good correlation with the Ordnance Vehicle Tests. The magnitude of the advance in performance made possible by the new super-duty lubricant is clearly indicated by its band which covers the entire width of the chart, fully meeting and exceeding the Buick 10-A test in high-speed requirements and the Super-L-20 and L-37 in high-torque requirements. The new products have been designated "Multipurpose-Type Gear Lubricant (API Service GL4)."

Field Performance of Lubricant

Service tests have run the gamut from short-time high-speed tests in passenger cars to long-time endurance tests under very severe conditions for both

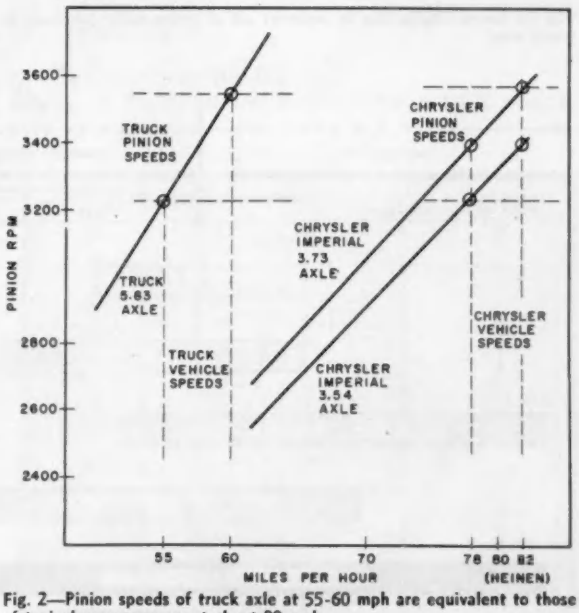

Fig. 2—Pinion speeds of truck axle at 55-60 mph are equivalent to those of typical passenger car at about 80 mph.

passenger cars and heavy-duty trucks. Following are some examples for passenger cars:

1. 25,000-mile durability tests by car manufacturer: New type gear lubricants gave excellent gear and bearing protection, considered superior to factory-fill lead-soap, active-sulfur product.
2. Similar test: Reference Oil 10–90 used with excellent results.
3. 500-mile high-speed run by car maker: Rear axle failure with factory-fill lubricant. Reference Oil 15–90 used without distress for record run.
4. Endurance high-speed run by car maker: Commercial 15–90 level lubricant used for very successful multirecord run.
5. Stock car racing: Owner of stock car team troubled with axle failures using lead-soap active-sulfur lubricant. Reference Oil 15–90 and commercial 15–90 level eliminated failures.
6. Shock tests by car maker: New lubricants of 10–90 and higher level gave excellent antiscoring protection.
7. Sustained 60 mph run by additive producer: Excellent results in 50,000-mile run with new lubricants in 1955 and 1956 cars.

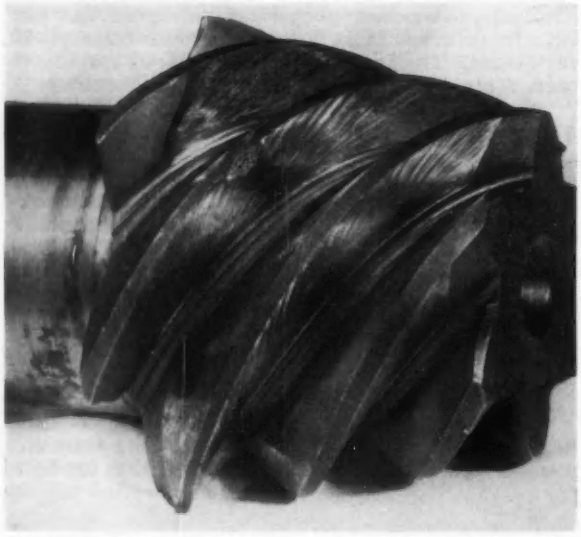

Fig. 3—Severe ridging due to incorrect use of active-sulfur lubricant in truck axle.

In some of these tests, the new lubricants were successful where factory-specified products had failed.

Commercial car builders have a big stake in the new lubricant development because some of the new axles appear to be lubrication-limited. Both truck and axle builders have cooperated fully in testing and some of the results are given here:

1. Trucking fleet—New England: Service failures due to scoring with factory-fill SAE 140 were eliminated by switch to new 15–90 level lubricant, and gears which had started to score were healed.
2. Canadian division of large truck and coach builder: Service failures at relatively low mileage with factory-fill lubricant. New type 10–90 gave definite advantage.
3. Northwest logging: Complete satisfaction in performance after three-year use.
4. Military vehicles—Yuma Tests: Scoring and other failures with MIL-L-2105 eliminated.
5. Logging vehicles in Northern California: Gross loads in excess of 180,000 lb over roads bulldozed out of forests with an uphill grade of 21% for 2½ miles. Short axle life with factory-specified lubricant. New type lubricant and periodic oil change achieved equivalent of over 100,000 miles per vehicle without lube trouble.
6. Taxicab fleet in Midwest: 1956 cabs being test operated on new lubricant. 25,000 miles of 50,000 ultimate schedule run without difficulty.
7. Heavy-duty Midwest fleet: Tractor-trailer units with dual-range rear axle in 100,000-mile test show excellent gear condition on initial intermediate inspection.
8. Lumber trucks on West Coast: New differential gears required three or four times a year in operation involving hauling 140,000-lb loads to sawmill. No gear replacement since changing to new 10-level lubricant a year ago.

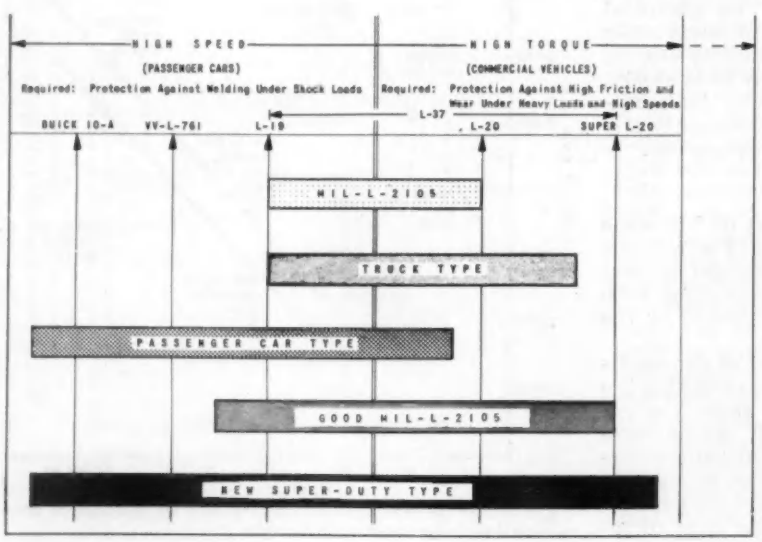

Fig. 4—Various types of gear lubricant and their relative abilities to meet growing axle needs. Note the wide band of the new super-duty type.

The reference gear lubricant referred to has a scale running from 0 to 15, with 0 (straight mineral oil) being the low end of the scale and 15 (high e-p additive content) being the top performance level. This reference quality number is followed by a 75, 80, 90, or 140 (as 15–90) to designate the viscosity grade. The reference quality numbers apply solely to anti-scoring level and cannot be used to describe the performance of a lubricant under high-torque, low-speed condition.

Other Properties

The new super-duty lubricant's advance in gear and bearing protection has not been made at the expense of other important properties. It meets and exceeds the Specification MIL-L-2105 requirements for protection against low-temperature rusting and high-temperature corrosive attack. It has excellent resistance against oxidation and deterioration under high-temperature conditions in the presence of catalytic metals, the necessary foam-resistant and storage-stability characteristics, and is compatible with the older type of lubricants, although mixing is not recommended because it detracts from the superior built-in qualities of the new product.

All field tests just mentioned were conducted with single- or double-reduction hypoid axles. Some experience has been obtained from worm-gear applications. For example, after a successful experience in a West Coast fleet with lubricant of 6-Reference level, one company changed to a 10-level product and reports success in worm gears. Another company has started tests with 70,000-lb dual-worm gear units running from Denver to Salt Lake City. Results are satisfactory in the few months of operation.

The locking or nonslip differential is now interesting car manufacturers, but as yet work has been insufficient to establish the extent to which these units affect lubrication requirements because of so-called "chatter" tendencies. Thus far, reports have been contradictory and confusing.

To Order Paper No. 161 . . .
. . . on which this article is based, turn to page 5.

Aircooled Diesels . . .

. . . thrive on extremely tough operations. Arctic cold . . . desert heat . . . instant starts of cold engines . . . don't faze these versatile workhorses.

Based on paper by **F. W. Lohmann,** Kloeckner-Humboldt-Deutz AG and Diesel Energy Corp.

THE aircooled diesel is particularly adapted to difficult operating conditions, such as:

1. Extremes of temperature.
2. Where cold engines must be started instantly, or where engines must be started and stopped frequently, or run for long periods at very low loads.

Extreme Temperatures

The aircooled diesel engine can operate more efficiently than the water-cooled diesel and without any modifications or special aids over a range of – 40 F to 150 F and above.

For example, if we imagine an increase of ambient temperature from 68 F to 140 F, the cooling efficiency of a water-cooled engine designed for optimum operation at 68 F would be reduced by 61% as against 26% for the aircooled engine.

If we increase the ambient temperature to 185 F, it becomes impossible to operate the water-cooled engine, no matter how large the radiator. The aircooled engine, however, is perfectly capable of operation at such a temperature, with a power drop according to the increase in ambient temperature.

Frequent Starts and Stops

The aircooled diesel may be started and stopped frequently, or run for long periods at loads as low as 15% of the maximum rated output, without structural or physical damage. When the water-cooled diesel is operated under such conditions, it suffers greatly. The aircooled diesel is, therefore, ideal for standby generators used by the military, railroads, hospitals, and the like.

The Deutz aircooled diesel, for example, can attain proper operating temperatures and deliver its rated power output in less than 5 sec from standstill, as shown in Fig. 1.

To Order Paper No. 153 . . .
. . . on which this article is based, turn to page 5.

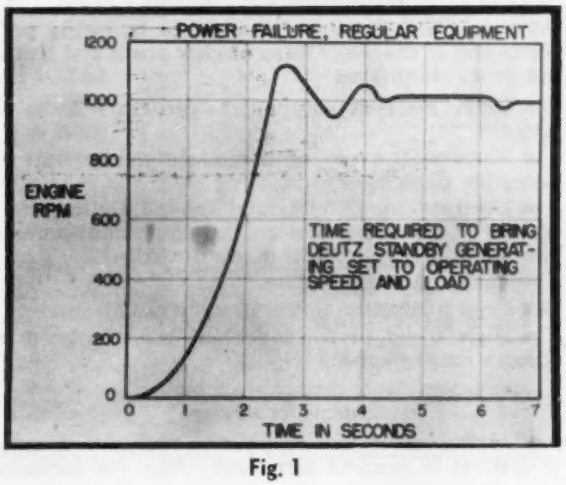

Fig. 1

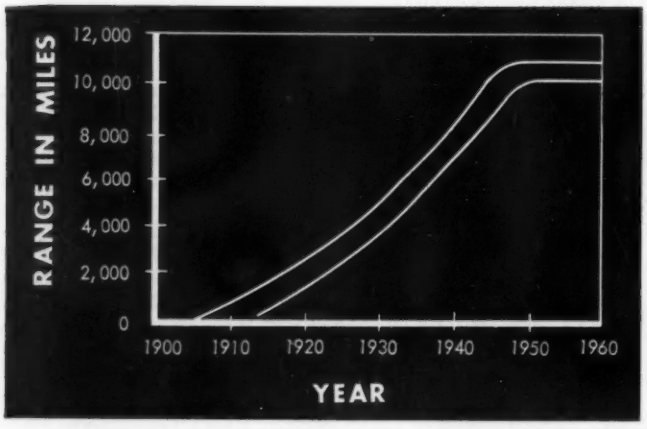

Fig. 1—Carrying chemical fuel puts a top on the range of aircraft.

Range Barrier Is Shattered by

Based on paper by

R. W. Middlewood and R. B. Ormsby, Jr.,

Lockheed Aircraft Corp.

THE RANGE barrier can be broken by nuclear powered aircraft as the sound barrier was broken by jets. The weight of a nuclear powerplant plus its fuel is fixed, while the energy needed for flight is practically unlimited. The payload of the ship doesn't have to be cut to carry more fuel for more range, as is the case with chemically powered sisters.

Optimistic projections of materials and designs of conventional airplanes will give a range of only double the 3500 miles achieved by today's chemically powered airplanes. This barrier is shown in Fig. 1 with the 11,000 mile top range a record flight without normal payload. For round-the-world flying a new approach is needed.

Performance Requirements

Efficient air logistics demand the following performance, if the weak links of slow boats and trains are to be eliminated:

- Carry heaviest equipment—presently 25 to 50 tons.
- Handle all types of cargo—no mechanical or radiation damage.
- Use existing airfields and ground equipment—special and cumbersome ground equipment defeats the mobility required in modern warfare.
- Fast and easy loading.
- Crew utilization not limited by radiation.
- High speed performance—at least as good as today's cargo planes.

Atoms for Airplane

Shielding crews and cargo from radiation damage is critical in nuclear airplanes. Also the airframe design must accommodate new weight distribution requirements.

A reactor produces gamma and neutron radiation. The first is like X-rays and requires lead or another dense material to stop them. The second is easily stopped by hydrogen. The gamma radiation continues after the reactor is stopped; this is called the shut-down dose.

Protection comes in three forms: get far away from the reactor, put lead around the reactor, and put lead around yourself. A combination of these gives the lightest airplane.

Two small reactors will require more lead than one large one, since the reactor shield weight is not proportional to the power. The exception to this is when two reactors are mounted at the wing tips. Here advantage is taken of the increased distance from reactor to crew.

The shielding performance breaks into three parts:

- No cargo damage—see Fig. 2 for radiation damage to materials.
- Low crew dosage—maximum radiation for humans is 1/10,000 that for glass, see Fig. 3.
- No special ground handling equipment—this includes shielding the shut-down dosage.

The problem of keeping the weight down is solved by dividing the shield weight between the reactor and crew. Since protection is needed in practically all directions to protect the cargo and satisfy ground handling requirements, enough lead is put around the reactor to knock-down the dosage to this level. The crew is further protected by an individual shield. The results of this divided shielding are shown in Fig. 4. The saving in weight over a single shield around the reactor is illustrated in Fig. 5. Distance from reactor is used to help protect the crew in this set-up.

Special Aircraft Designs

A nuclear airplane should look similar to conventional models. However, here are some different design problems:

- Reactor shields have to be force-circulation

NUCLEAR AIRCRAFT

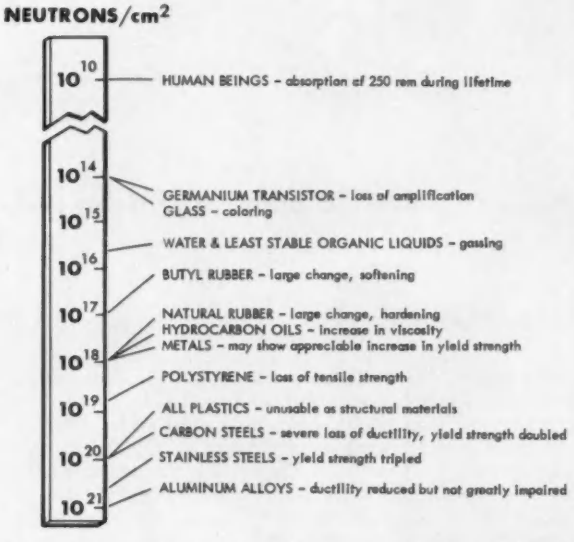

Fig. 2—All aircraft and cargo material have to be pegged for radiation tolerance.

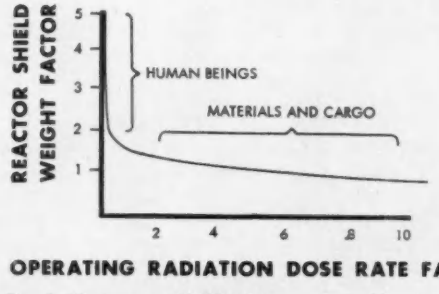

Fig. 3—Humans are 10,000 times more sensitive to radiation than their planes or cargos.

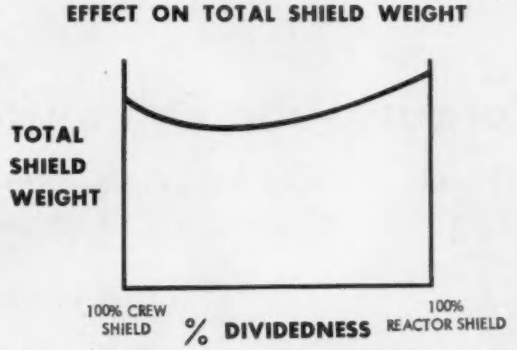

Fig. 4—Splitting the reactor shield decreases the airplane weight.

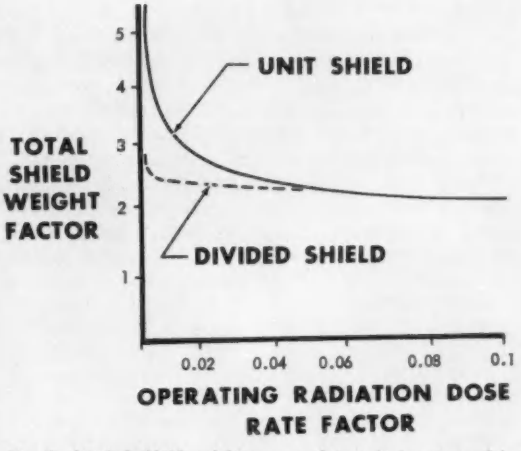

Fig. 5—Divided shield weight compared to unit (reactor only) shielding.

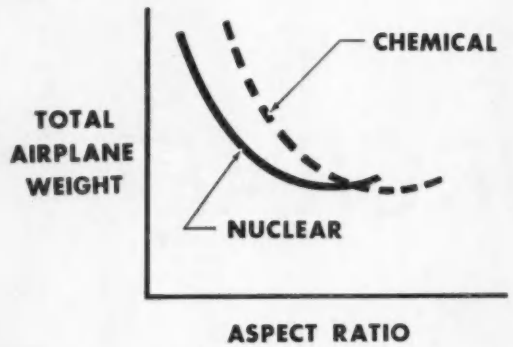

Fig. 6—Aspect ratio is lowered for given gross weight in nuclear aircraft. This is a combined effect of the powerplant and wing structural weight.

cooled. Since the reactor is hot after shut down, a separate powered cooling system is needed.

- Nuclear fuel has to be "cleaned" as fission produces by-products that kill the reaction.
- Reactor and shield weight cannot be distributed over the airframe as can chemical fuel weight.
- Wing mounted reactors call for a lower aspect ratio wing for a given gross weight—see Fig. 6.

Future Developments

Major shield weight savings will probably come through better temperature performance of materials. By running the reactor hotter, a smaller unit would be needed. This means less metal to cover a smaller reactor and less reactor power to drive the propellers. The latter would result from higher engine thermal efficiencies.

To Order Paper No. 206 . . .
. . . on which this article is based, turn to page 5.

Torque Tube Drive Line . . .

. . . made necessary by low-silhouette car helps to solve old problem of noise and roughness due to propeller shaft vibration.

Based on paper by **L. E. Muller and Elmer Greene,** Buick Motor Division, General Motors Corp.

THE use of two propeller shafts to give a "bent" effect in the low silhouette torque tube drive line results in much higher critical speeds, high enough to make noise and vibration negligible at normal driving speeds. Moreover, the supported universal joint used with the drive line aids in keeping noise and vibration at a minimum.

Vibrations, referred to as high speed roughness, were experienced with some cars in 1956. This roughness peaked at approximately 55 and 110 mph with a trace at 27 mph. The frequency appeared to be between 85 and 90 cps. Test data, recorded with a dynamic micrometer and vibration pickup, revealed a propeller shaft excursion, nearly 0.25 in. peak to peak, being reached at approximately 86 cps.

Passenger compartment noise also mounted with increase in propeller shaft speeds. At 30 mph, a propeller shaft runout of 0.015 in. and a 0.002 in. whip for a total of 0.017 in. excursion, kept the compartment noise at a low level. High-speed photographs at 30 mph verified the small excursion. At 60 mph the total propeller shaft amplitude of vibration reached 0.040 in. and compartment noise was up 13 db. Shaft speed was again raised and the critical speed approached. The excursions approached 0.25 in. travel at 86 rps while the compartment noise level jumped another 6 db.

The 0.25 in. amplitude of the propeller shaft at speeds near resonance served as the exciting force for a number of underbody components. The torque tube itself was bent in vibration as much as 0.040 in. at its mid-point. The strut rods, rear shock absorbers, and rear springs were driven at relatively high amplitudes and took on snake-like vibration modes at this frequency. A change was in order; shorter shafts would have higher critical speeds, but wheel base could not be shortened.

At this point the low silhouette car arrived, calling for a low drive line. The new bent drive line required a universal joint and bearing at the bend, and two propeller shafts, each shorter than the original single shaft. Under similar test setup, the new drive line was found to have its critical speed at 135 cps, corresponding to over 230 mph. Operation was found to be very smooth up through the speeds that were critical with the longer single shaft.

Other Causes of Drive Line Roughness

The degree of roughness created by a cardan type of universal joint depends on two conditions: (1) angularity between the two shafts, (2) the offset between the two shafts. Here we consider the latter, because it is least often discussed, and assume a moderate angle.

With the self-supporting type of joint, an exciting force will be produced equal to 0.5 the weight of the propeller shaft in ounces plus the weight of that part of the universal joint which is offset, times

the offset of the two shafts in inches. To prevent objectionable vibration this offset must be held to about 0.0015 in. for a 12-lb shaft. We understand that 0.006 in. is the minimum limit production can hold. The frequency of the unbalanced vibratory force produced is equal to propeller shaft rotational speed.

With the supported type of joint, the propeller shaft will rotate on the same center in service as was used in manufacturing and balancing. Consequently, the aforementioned condition of unbalance cannot exist.

However, a second order vibration will be produced by the universal joint spider which is compensating for the misalignment of the two yokes. The spider follows an orbit which has twice the frequency of propeller shaft rotation, hence the twice-per-revolution excitation from a misaligned non-supported universal joint.

The effect of supported universal joint misalignment on noise level compared to levels of other common noises, is shown in Fig. 1. Reference to this polar diagram shows that the non-supporting joint may be misaligned up to 0.005 in. in any direction from mechanical center with little if any detectable change in noise level. From 0.005 to about 0.010 in. misalignment, the noise level is increased by 5 db. Increasing yoke misalignment from 0.010 to 0.015 in. increases passenger compartment noise another 6 db. Such a large misalignment is far beyond production tolerances, but comparable with the self-supporting joint with only 0.007 in. experimental misalignment. This 0.007 in. is quite serious on a self-supporting joint considering that a conventional shaft will weight nearly 12 lb and will be offset this amount.

Fortunately, production tolerances can easily be held within ±0.005 in., the requirement for a quiet supported universal joint. The small mass of the spider traveling through its orbit with 0.005-in. or less offset does not produce an audible noise in the car.

Since the propeller shaft used with a torque tube is supported on front and rear bearings, there is a negligible first order vibration. And since the 0.005 in. torque ball alignment is feasible in production, there is little or no second order vibration. Near perfect (0.0015 in.) total limit can be maintained with the self-supporting joint to hold the first order vibrations to an acceptable level. It should be obvious, therefore, why the non-supporting joint is used, since the 0.005 in. parallelism, which results in no noise increase, can be held in production.

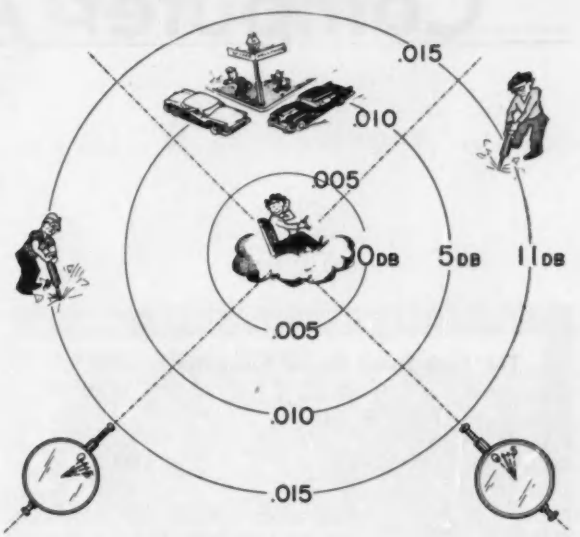

Fig. 1—Allowable misalignment of front and rear yokes of universal joint and its effect on twice-revolution passenger compartment noises.

Based on Discussion by

Russell A. Ash
Chrysler Corp

I CAN find only one major advantage in the torque tube setup. The convenient tube, lacking in the Hotchkiss drive, is an excellent place for attaching a pickup. Possibly we could include the advantage of eliminating the somewhat critical flange runout, a problem of the Hotchkiss drive. The latter has been minimized by special attention to balancing procedures and by designing the shafts so that their critical speeds are sufficiently removed from the operating range of the car.

By using the 3-joint system we have arrived at shafts whose critical speeds are well above operating range. This eliminates the flange runout problem and gives a drive line virtually free of any roughness at all cruising and high speeds. The only new problem is center bearing shudder.

Generally, there are three reasons why shudder may be present with a 3-joint design. (1) The optimum universal joint angles are critical of adjustment, and difficult to maintain by production methods, (2) the joint angles may vary widely between part- and wide-open throttle conditions, (3) joint angle variation with passenger load changes may be extreme.

The joint angle problem can be minimized by increasing rear axle windup resistance and by changes in the suspension geometry to the extent allowable for ride considerations. Should all else fail, the subjective result of unsatisfactory center bearing forces can be reduced by improved isolation at the center bearing support. Recent developments of this nature have been successful, and the future of the 3-joint Hotchkiss design looks bright.

To Order Paper No. 120 . . .
. . . on which this article is based, turn to page 5.

Computer Aids in Design

The High-Speed Digital Computer provides invaluable aid in designing a three-joint driveline for use with the Hotchkiss suspension. Its systematic choice of optimum design assures little noise or vibration at normal driving speeds. In short, it makes the three-joint design practical, enabling stylists to achieve the lower overall car height they desire.

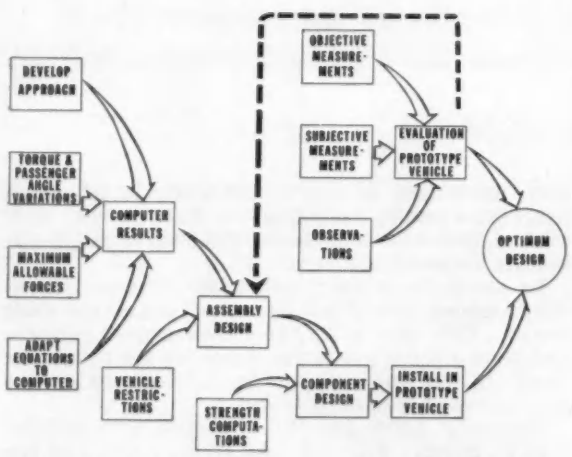

Fig. 1—Road map of development program utilizing the digital computer.

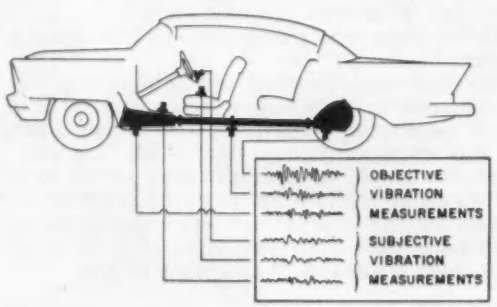

Fig. 2—Instrumentation for evaluation tests.

USING a high-speed digital computer, an optimum three-joint driveline can be established for use with the Hotchkiss suspension. Subjective and objective evaluation of this optimum design will reveal critical areas where improved vibration isolation will provide the basis for a realistic and satisfactory design.

Equations can be set up, in terms of the angles, dimensions, and input torque of the three-joint system, to determine the magnitude of the dynamic forces at each of the universal joints. Through the use of these equations, a system of optimum design can be determined for any one set of torque and passenger conditions. The trouble here, however, is that the arrangement of the angles and dimensions is radically changed for the Hotchkiss suspension each time the torque and passenger conditions are changed. So, although it is possible to have optimum phasing for one set of torque and passenger conditions, any deviation will destroy the delicate balancing of the phase angles. However, only the case of maximum torque need be considered since any reduction in torque will decrease all three forces. This permits omission of the torque as a critical variable, requiring only a driveline design that minimizes the effect of varying the number of car occupants during full throttle.

Approach

Summarizing briefly the situation is this. We have a driveline that is susceptible to undesirable vibration. Along with this we have equations which will predict the extent of how good or bad, vibrationally, the driveline configuration will be. The general approach selected to solve this situation was to analyze a large number of driveline configurations, changing one dimension at a time, and select only those which looked promising for the full torque condition and for various passenger combinations.

Early efforts to solve these equations manually showed that it took approximately ½ hr per equation, or a minimum of one hr for each configuration. Since we may want to examine a minimum of 5 variables with as many as 10 arrangements each, a total of over 100,000 configurations are required, necessitating some 100,000 man hours or 50 man years if manually computed.

This estimate led to an investigation into the pos-

# of Three-Joint Driveline

Based on paper by **R. H. Bollinger,** Ford Motor Co.

sibility of using a high-speed digital computer. The preliminary study showed that an IBM 702 computer requires approximately 5 hr to solve these same 100,000 equations. A study of the role this computer would play eventually resulted in the program outlined by Fig. 1. While this "road map" indicates that the computer results are the "hub" of the program, the computer does not by any means completely solve this problem. The computer requires experimental data and information fed to it, and the results must be evaluated and considered by engineers in the light of some very practical considerations.

Examining Fig. 1 it is seen that in addition to instructing the computer to vary the dimensions of the driveline under study, it is also required to relate to the computer those changes which would be due to windup of the axle during a full throttle jump start and those changes due to varying the number of passengers. In order to avoid examining all 100,000 driveline results, the computer is programmed to indicate only those configurations with forces less than some preselected values. Thus, maximum force information must be first experimentally determined and related to the computer.

Continuing along the "road map," the results of the computer study are combined with vehicle restrictions, and again some otherwise promising configurations eliminated on this basis. The assembly design, together with strength and cost considerations, results in a component design and, after installation, eventually leads to a three-joint prototype.

Evaluation

After the prototype car is assembled with the three-joint configuration of the first design, the next step is to determine how effective this design is in eliminating noise and vibration. Several observation rides with different passenger arrangements should quickly reveal the acceptability of the results. If these show that further work is required, vibration measurements should be made. This means measuring the objective type vibration of the transmission, center joint, and differential and simultaneously measuring the noise level and the subjective type vibration of the footwells and steering wheel (Fig. 2). These measurements are made under various conditions of driving and passenger arrangements, especially for those test conditions that have proven unsatisfactory.

Results from a typical full throttle acceleration test showing the vibration of the front footwell (subjective) and the vibration of the transmission, center mount, and differential are shown in Fig. 3. These curves show that the transmission force is too great, causing a noticeable vibration at 40 mph. However, the earlier tests showed that the center mount for this installation could receive a slightly higher force without increasing the noticeable vibration inside the car. By reproportioning the original allowable forces a different set of computer results may now be appropriate. That is, another driveline configuration should be sought which shows a reduced force at the transmission at the expense of an increased force at the center joint and without materially increasing the force at the differential. This rebalancing, represented by the dotted line on the road map (Fig. 1), is a refining process and should not cause a tremendous change from the initial configuration. The new configuration is given a new set of tests, with the recycling repeated until a satisfactory design is achieved.

To Order Paper No. 119 . . .
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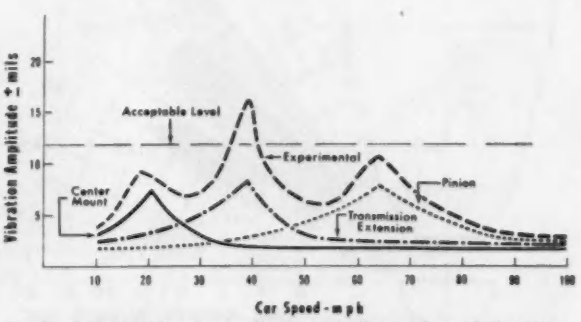


Fig. 3—Evaluation data for readjusting driveline angles and dimensions.

Engine and Airframe Overheating

JET ENGINE

Based on paper by

Robert C. Kohl
and Joseph S. Algranti,

Lewis Flight Propulsion Laboratory, NACA

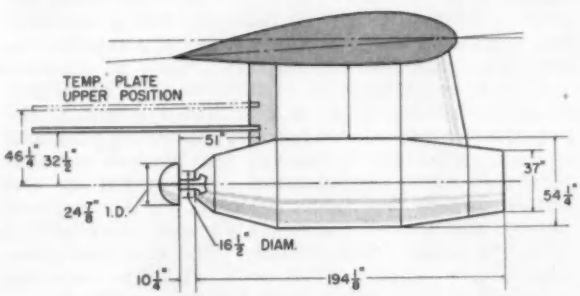


Fig. 1—Hemisphere thrust-reverser test arrangement.

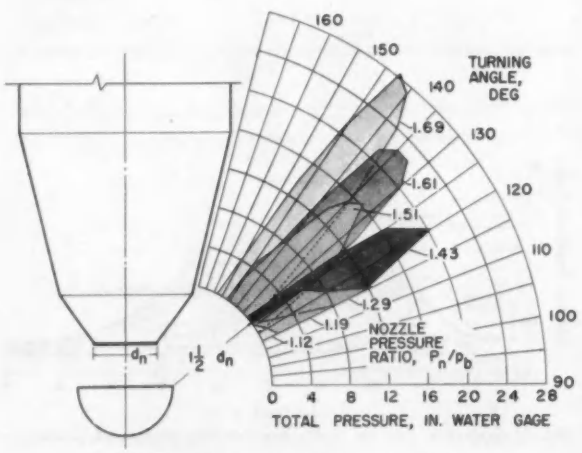


Fig. 2—Thrust-reverser discharge flow angle.

REINGESTION of hot gases and overheating of pylons and under-surfaces may be a serious problem with thrust reversers on pod-mounted turbojets, NACA tests show. Engine and airframe overheating developed during stationary and low-speed operation of a hemispherical thrust reverser during a full scale test.

Scale model reversers, operated with cold air, paved the way for the design of a split hemispherical target behind a jet engine. Fig. 1 dimensions the arrangement used to simulate operation of a B-47 and B-66 pod. The upper and lower plate positions correspond respectively to the wing location of these aircraft.

Temperature Problems

Maximum reverse thrust would occur when an engine is operating at full speed and its exhaust gases are turned 180 deg, yet this would direct the gases forward over the engine pod to where they could reenter the intake of the engine. Fortunately the forward motion of the airplane washes the hot gases rearward at the landing speeds of jet aircraft. However, as the plane slows down, this effect is overcome and hot gases sweep over the pod and into the engine.

Reducing the engine speed counteracts overheating since exhaust gases do not turn as far forward when the engine nozzle pressure ratio is lowered. Flow patterns shown in Fig. 2 progress forward from 120 to 143 deg for pressure ratios of 1.12 to 1.69. At a pressure ratio of 1.35, the gases have turned sufficiently that they adhere to the engine pod rather than dilute themselves in the surrounding air.

The results shown in Fig. 2 are for stationary operation. Superimposing the forward motion of the airplane delays the start of reingestion as shown in Fig. 3. Here the effect of engine speed is also shown. Reingestion starts at 62 knots for full engine speed but is delayed until 37 knots at 75% of full engine speed.

Reingestion can damage the engine and the airframe. Increasing the inlet gas temperature boosts the exhaust temperature. The cycle repeats and the inlet temperature rises. This continues until the engine overheats to failure. During this sequence, the airframe temperature increases. The

Can Limit Performance of

THRUST REVERSERS

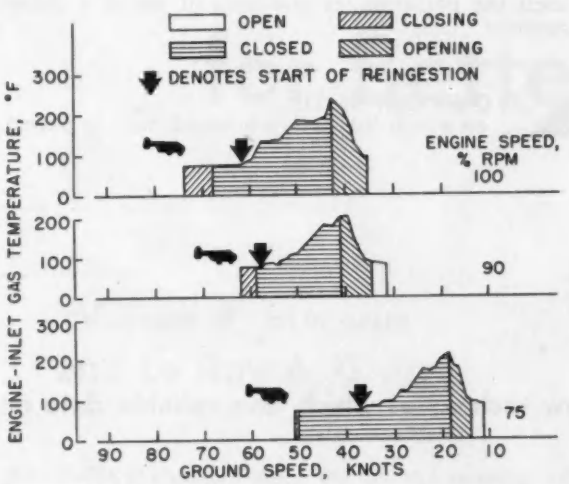


Fig. 3—Effect of ground speed on inlet temperature rise.

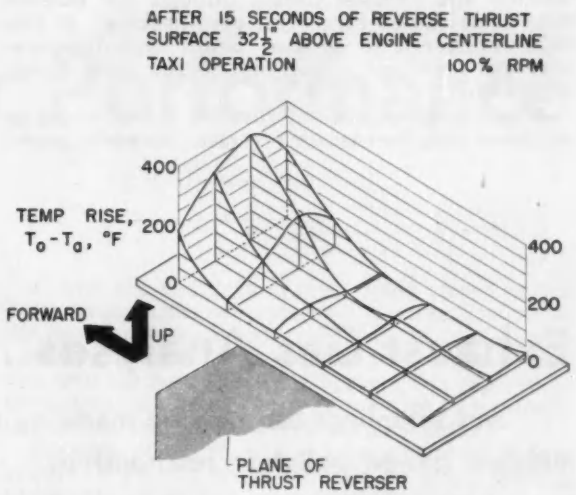


Fig. 4—Temperature patterns on simulated-wing surface.

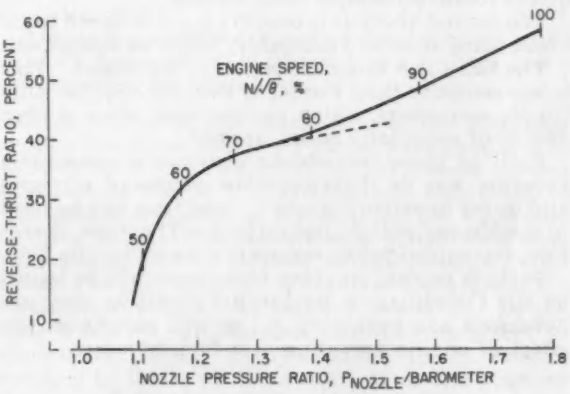


Fig. 5—Reverse-thrust ratio, hemisphere reverser.

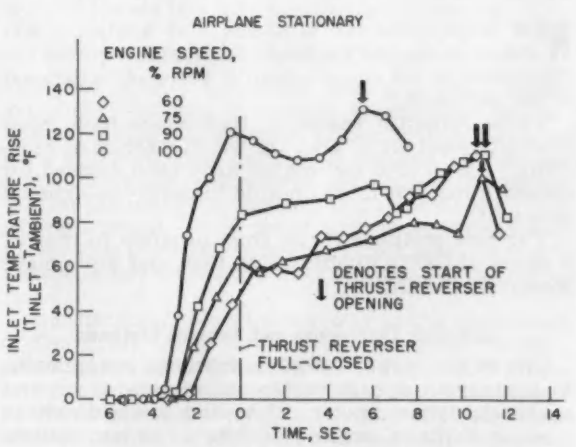


Fig. 6—Inlet temperature rise due to reingestion.

braking action is reduced since hot inlet gases reduce engine output. This in turn increases the time needed to brake and allows the temperatures to soar higher.

The effect of thrust reversal on a simulated B-66 wing is shown in Fig. 4. Similar temperature patterns are produced for different durations of reversal, engine speeds, and wing locations. The point of maximum temperature rise follows the point of exhaust gas impingement on the surface. See Fig. 2 for gas patterns.

Model tests indicate that reingestion is retarded if the fineness ratio of the pod is increased. This was borne out by a second installation at the tail of a jet fighter. A cascade-type reverser could be used for 2 min before triggering the over-temperature warning system in the aft fuselage section.

Performance

During the cascade tests, a 3% forward thrust loss was attributed to stowing the vanes in the center of the tailpipe. Also leakage between the turbine and exhaust nozzle through the cascade door seals caused structural over-heating. If this type reverser is to be used, better high temperature gas seals and a non-obstructing vane design are needed.

A maximum of 35% of forward thrust could be achieved with the cascade reverser. However, model test predicts 43% if tail pipe areas are better matched. Even with excessive tailpipe flow area, the average landing deceleration was increased from 0.12 to 0.216 g when the reverser was used.

The hemispherical reverser achieved a reverse thrust ratio of 58% at full engine speed during stationary tests. This corresponded to a nozzle pressure ratio of 1.78. If higher performance engines are used, a 65% reverse thrust ratio is predicted from model tests for a nozzle ratio of 2.5.

The static performance of the reverser, shown in Fig. 5, breaks upward at a pressure ratio of 1.35. This is the adherence point of the gases to the pod. The clinging gases lower the static pressure on the pod giving an additional braking force.

The performance of the hemispherical reverser was out in half when the engine inlet temperature rose to 200 F due to reingestion. During static tests the inlet temperature jumped a maximum of 70 F a sec at full engine speed. A temperature-time plot for different engine speeds is given in Fig. 6. From this plot and Fig. 3 it is seen that reingestion can limit the performance and time of use of a thrust reverser.

To Order Paper No. 113 . . .
. . . on which this article is based, turn to page 5.

Exhaust Gas Analyses . . .

. . . and samplings can now be made by new techniques which give reliable data on exhaust gas-air pollution relationships.

Based on paper by **B. M. Sturgis,** Leader, CFR Group on Composition of Exhaust Gases

NEW techniques for sampling and analyzing exhaust gases are available to provide reliable information on the contribution of automobile exhaust to air pollution.

Three separate sampling techniques have been devised, based on a "grab" or batch method of sampling. Also, three techniques have been devised for determining the total organic material in exhaust gases.

The new methods result from progress to date of a panel of CRC's Coordinating Fuel and Equipment Research Committee.

Sampling Techniques and Analysis Methods

One of the "grab" sampling methods is applicable to engines on dynamometer test stands, or cars on a chassis dynamometer. A second is applicable to moving vehicles, while the third—which collects samples of exhaust gas from moving vehicles—is specifically for determination of oxides of nitrogen.

One of the three analysis methods is a mass spectrometer technique, which is quite rapid and requires relatively simple calculations.

The second analysis procedure is an infrared technique using standard laboratory infrared equipment.

The third is a Combustion Orsat technique. This is less sensitive than the other two, but requires only simple equipment which can be used when a high degree of sensitivity is not needed.

Each of these techniques provides a reasonably accurate way to determine the oxides of nitrogen and water in exhaust gases . . . and they can be used in a wide variety of applications. They are, therefore, recommended to research workers in this field.

Further reports on other techniques will be issued by the Coordinating Research Council as they are developed and evaluated . . . as will reports on the effect of engine operating and fuel variables.

To Order Paper No. 172A . . .
. . . on which this article is based, turn to page 5.

Redesigning IHC Scrapers

for Better Performance

Based on paper by

William P. Macarus and Le Roy A. Grotto

International Harvester Co.

GEOMETRY changes made during the redesign of an IHC self-propelled scraper resulted in considerably easier and faster loading and unloading. And because the redesign produced a more efficient structure, the machine was made capable of carrying heavier loads and became more competitive costwise.

Among the more important of these changes made in the scraper, which is powered by a 2-wheel prime mover, were the following:

1. In the gooseneck connection to the octagonal section the upper and lower plates were extended to wrap around that section. The plates were tapered to minimize the section change and connected to the octagonal section by welds along the edges and by plug welds. The vertical side plates were continued back to the octagonal section, forming a connection to that section. A transverse plate was installed, connecting the vertical side plates in the area where the reinforcing side plates connect to the vertical plates. The reinforcing side plates were reduced in thickness from the 1 in. of the previous design to ¾ in. The air line hole through the reinforcing side plate was moved from an area of high stress to one of minimum stress.

2. The top and bottom reinforcing straps of the draft frame arms are extended to wrap around to the center of the octagonal section. Corner gussets connect the draft frame arms to the octagonal section and are boxed in. The box plate is tapered at the connection to the draft frame arm to minimize the section change caused by the connection.

Changes other than the foregoing (which are shown in Fig. 1) were confined to small details. Some of these were: carrying a weld around a corner instead of terminating at the corner, and locating necessary stress risers in areas of minimum stress, such as the air line hole previously mentioned.

Reasons for Design Changes

Generally, the gooseneck and the draft frame arms are subjected to bending loads, while the octagonal section is subjected primarily to a torsional load, although some bending is present. Stresscoat and strain gage tests showed the gooseneck connection to the octagonal section to be one of the areas of high stress. The upper and lower connecting plates had the highest overall stress level, with the stresses going well above the yield point of the material.

Another area of high stress was at the connection of the draft frame arm to the octagonal section. Also highly stressed was the area of the draft frame arm near the inspection plate opening. The gussets connecting the draft frame arms to the octagonal section had areas of high stresses at the octagonal section junction and the draft frame arm junction.

The stresscoat and strain gage tests on the original and subsequent design taught several lessons

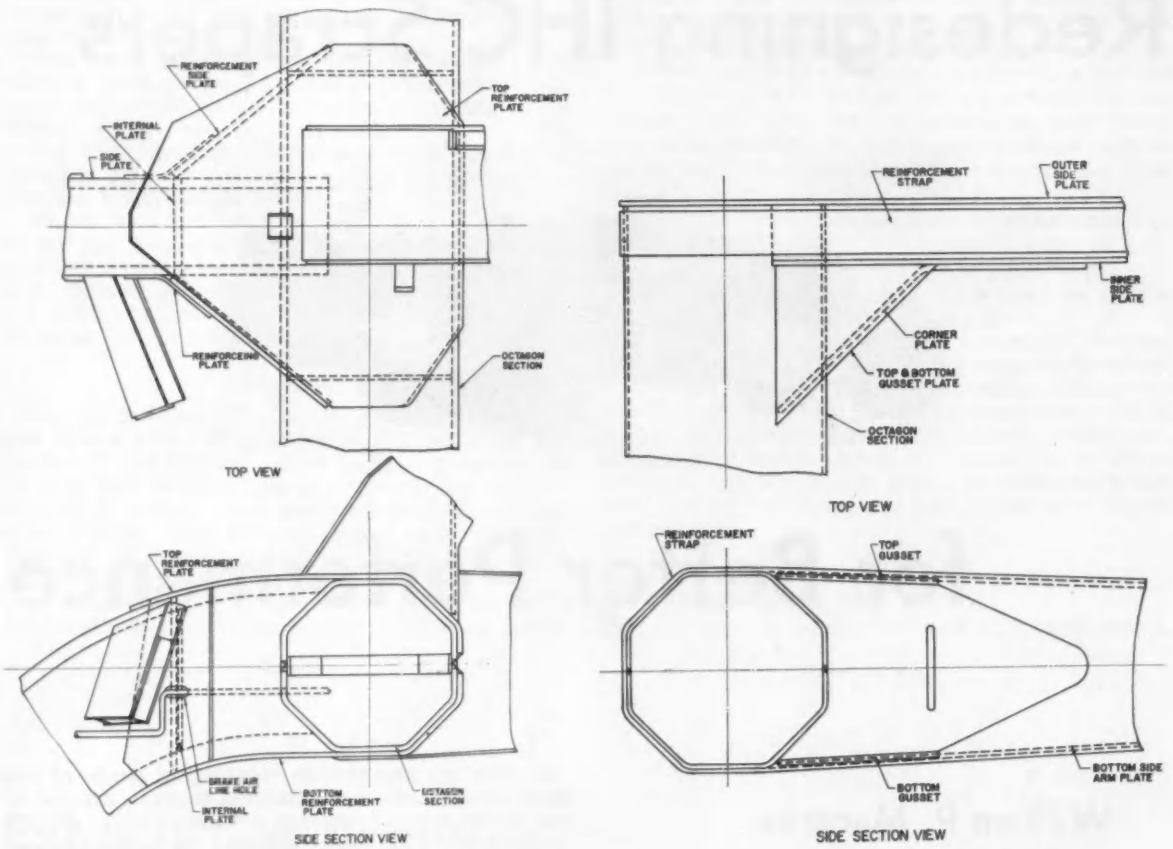


Fig. 1—Final design of IHC scraper. (Left) connection between spindle and draft frame. (Right) corner connection of scraper draft frame.

valuable in the final design. Among the important points were:

1. Need of structural flexibility to absorb shock loads.
2. How to improve the connection between the gooseneck and the octagonal section, and the draft frame arms and the octagonal section.
3. The importance of blending sections for smooth distribution of loads.
4. Keeping stress concentrations at a minimum.

Improvements in Final Design

The overall stresses in the areas of interest were about 30% lower than in the original design. The gooseneck connection to the octagonal section distributed the loads to make the stress level in this area generally uniform. Plug welds were an important factor in this. In the gooseneck itself, the transverse plate tying the two side plates together to work as a unit was of great importance to the success of the design. The connection of the draft frame arms to the octagonal section provided a simple and efficient connection with little disturbance to the necessary torsional flexibility of that section. This flexibility made possible reduction of shock loads, hence the stresses. Last but not least, minimizing stress concentrations created a design where the stress distribution was uniform.

Even when operating stresses are known, it is not always possible to make the correct design changes. However, with the proper use of experimental stress analysis the designer will know the conditions resulting in the most critical stresses. He will also know shortly if the design is satisfactory. Finally, when design modifications or corrections are necessary, he will discover quickly whether the modification was really a correction or a further aggravation.

To Order Paper No. 182 . . .
. . . on which this article is based, turn to page 5.

Captive-Air Tire

. . . may make spare tire obsolete equipment. Tests demonstrate capacity to carry car over 200 miles at 50 mph after puncture.

Based on paper by **Philip W. Drew,** Goodyear Tire & Rubber Co.

GOODYEAR has developed a two-compartment tire, each compartment having independent pressure. If the outer compartment or standard tire part is punctured and air escapes, the inner tire or shield supports the car load, allowing driving to be continued until safe or convenient to make repairs.

Fig. 1 shows a cross-section of the tire assembly. It consists of a standard nylon tire with continuous inner liner and a safety shield of two rubberized plies of nylon. The nylon shield divides the tire into two independent presure compartments. Air pressure in the inner compartment is controlled by a regular rim valve, which is standard on all tires, while pressure in the outer compartment is controlled through a new type of compression-sealed sidewall valve.

Actually, it is the combination of nylon tire cord and the sidewall valve that make possible this dual-compartment construction. Rayon is satisfactory for ordinary service but fails quickly in the tire shoulder during flat-run service. Moreover, with a rayon constructed tire the shield eventually wears out due to rubbing between tire and shield incident to slippage caused by their differences in radii. Only nylon will hold its shape and shrink enough to reduce carcass deflection during the high temperatures created by the friction and slippage between the inside of the tire and the shield.

The sidewall valve consists of a molded hole in the tire sidewall. It does not injure the cords or weaken the tire because it is made by inserting a molding pin into the tire before vulcanization. After the tire is cured, the pin is removed and the sidewall valve inserted. The valve is approximately twice the size of the molded hole, assuring a high compression seal. The tire is inflated and deflated through the sidewall valve with a hypodermic-type needle.

The tire and shield are separate units, both in manufacture and in use, which makes for ease of replacement and repair. The shield is inserted in the tire before mounting and from then on practice is conventional. Inflation of the shield to recommended pressure is accomplished first through the regular rim valve, then the outer compartment is inflated through the sidewall valve. Different pressures can be maintained. This offers possibilities of a softer ride, using low pressure in the outer compartment and high pressure in the shield to promote stiffening of the tire sidewall and greater stability.

Deep punctures caused by long nails are prevented by the Ny-Wire breaker shield, which is built with a two-ply wire breaker or cover to bend the nails over and render them harmless. The shield floats in space with very little flexing until put to work by failure of the outer tire, hence, a puncture-resistant layer can be put on the shield without the normal concern about flex resistance.

Tests of the tire have been carried on by equipping five taxicab fleets. These have rolled up 20 million miles under close observation with the following comparative results:

Type of Tire	Road Delays per 1,000,000 Miles
Tube	190
Tubeless	55
Captive-Air	0.64

To Order Paper No. 122 . . .
. . . on which this article is based, turn to page 5.

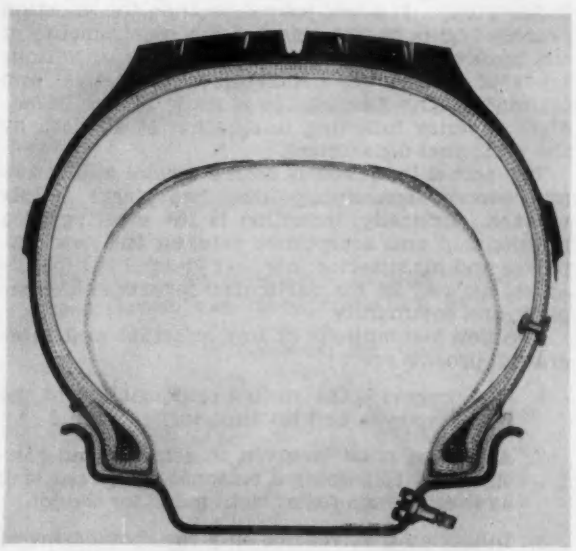


Fig. 1—Cross-section of dual-compartment, Captive-Air tire. When outer compartment is punctured, the inner compartment, or tire, carries the load until convenient to make repairs.

Developing Human

OF ALL the ingredients needed to produce a successful company, by far the most important is its people. Important factors in developing human resources include the:

1. Selection and induction of new personnel.
2. Creation of a climate for the integration of management personnel.
3. Development of skilled personnel through training.
4. Development of nonmonetary incentives.
5. Communications problem.

Selecting and Inducting New Personnel

Since the growth of any organization begins with the selection of people, more and more emphasis is being placed on sound selection techniques. Organizations are carefully analyzing a particular position opening to determine whether a real job exists, whether the job could be combined with others, or whether the job could be shared by people already in the group. If a real job exists, then the selection process begins by determining the requirements of the position, followed by full utilization of various types of interviews; nondirective, projective, and technical. The final choice is made by the immediate superior following integration of all data by the personnel department.

The actual induction is both a formal and informal process consuming from two weeks to six months. Basically, induction is the evolving of a relationship and acceptance between the new employee and his superior; his peer group, his subordinates, as well as his particular department, company, and community.

The key assumptions of any selection and integration process are:

1. The process is the mutual responsibility of the new employee and his superior.
2. Attention must be given to defining and continuously redefining a reasonable "job" as well as to selection of the "right man" for the job.
3. Induction involves not only the shouldering of responsibility for a particular job, but becoming integrated into the residential community as well.
4. The new employee requires a "feedback" on how well he is working into his job.
5. And, when the man and his superior are able to formulate intelligent plans for his future, the induction period is complete.

Creating the Climate for Integration of Management Personnel

Many companies are attempting to supplement shop-trained supervisors with college-educated personnel in the middle and upper levels of production management. The requirement is for a technically-minded man with a background in administration and possessing leadership ability. Essential to the development of this type of person is the proper climate for his integration within the organization. The following principles are basic to establishing such a climate:

1. Management must sincerely recognize a need within their organization for this type of personnel. Scepticism or passive participation on the part of management will undercut any possibility of integration as well as a climate for development or acceptance.

2. The number of college-educated personnel in any such integration should be a minimum.

3. Job rotation, "assistant to", committee work, or special projects for the management trainee all help to create the proper climate. Each individual must have a tailor-made program. If not, integration will usually fail.

4. It is necessary to blend the entire activity of the trainee into regular organization activity to avoid establishing the climate of "crowned princes". The climate for acceptance of college-trained people is based also upon the effort made to advance qualified supervisors with shop background at the same time college-trained men are advanced.

5. The responsibility of establishing the proper climate is not only management's but also that of the college men working in production. They must face up to the problems of nonacceptance, resistance, and the difficultness of obtaining identity with

Resources for Production

Based on secretary's report by **B. B. Hauserman,** Thompson Products, Inc.

the shop-trained supervisor. If the college man has the desire to be integrated into production, he will display a respect for the shop-trained supervisor as well as a desire to gain acceptance.

6. Any program, formal or informal, for the integration of college men into production management must be initiated and conducted by production management itself if the proper climate is to exist.

Developing Skilled Personnel

Training is tied to the basic survival objective of the company. Therefore, survival strongly affects broad management policies, plans, and practices.

Since training is one of the principal survival techniques, it must be an integral part of top management's long-range plans. If training is not a part of long-range planning, it will not contribute to the company objectives, but simply be an appendage.

It is generally recognized by all companies that we can no longer wait for people of high skill or engineering talent to "happen". We must make them happen. No set techniques, method, or pattern for the development of skilled personnel is universally applicable because each company is different in its structure, climate, and needs. To develop skilled personnel, the first essential is to determine accurately the needs. There is general agreement that there is a tendency to train for a nonexistent need, particularly in the area of high-skilled personnel. Based on the need of the company, the training of high-skilled personnel must be continually changing. A rigid standard for training probably is not developing people at all.

In the development of high-skilled personnel, the question is not how many people we can train, for we can never train enough. Rather the question is how much can we afford to spend on training. The basic need for technical or skilled personnel indicates that we can no longer rely fully on colleges to provide the answers. The greatest single source of human resources exists within the organization. Formal programs based on determining present employees with potential will help.

Equally important in searching out potential is a policy of universal opportunity for self-development. The individual guiding and coaching of the employee who has accepted the responsibility for his own self-development is the basic method. Management's basic acceptance of development is one of its major objectives. Couple this with a determination to take people from where they are, develop and foster their talents, and you have the answer to finding and training skilled personnel.

Developing Administrators

Each company is actively seeking to find and develop administrators within their organizations. Since an administrator is an individual and the particular function which he is managing will vary from company to company, it is generally agreed that potentially any source may produce people with an administrative ability. (Companies are facing up to the problem of technical people, who because of salary and status consideration, are forced to go into an administrative position. In many cases, the special technical skill of the individual is lost and he fails at the administrative level of getting work done through people. The concept of "parallel paths" for the technical specialists and the administrator with equal status and salary appears to be the answer here.)

The actual development of administrators falls

SERVING on the panel which discussed "Developing Human Resources for Production" were:

C. W. Goldbeck, panel leader
Thompson Products, Inc.

B. B. Hauserman, panel secretary
Thompson Products, Inc.

Dr. G. W. Gilman
Lockheed Aircraft Corp.

J. M. Hollyday
Martin Baltimore

J. P. Rutherfoord
General Electric Co.

Charles Hazard
Republic Aviation Corp.

Dugald Black
Bendix Aviation Corp.

into several categories and presents a number of problems.

In-plant programs including job rotation—These programs must have real meaning and developmental value—not be a "merry-go-round."

Job progression—A number of problems arise in this area: the basic time requirements involved in each job, the number of positions to be filled, and the utilization of each position.

Training courses—The difficulty here lies in measuring the actual achievement of the objectives which are sought.

The climate—Often the developmental program results in a frustrated trainee. New and different ideas are learned by the person in training but when he returns to a specific position, the existing climate is such that he cannot use the newly acquired skill or knowledge. This produces the frustration.

External aids in developing administrators include traditional educational institutions, professional meetings, seminars, and reading lists or literature.

Many companies feel, however, that the individual manager, who accepts the responsibility of multiplying his talents through other people, constitutes the long-range answer to developing additional administrators.

The intangible factors of encouragement, production, and attitude enter into the developing of administrators, and as yet, we have not developed evaluation norms to measure the effectiveness of these factors. This area of developing administrators will, in the years ahead, be of major concern to most companies.

Developing Nonmonetary Incentives

Following the careful selection, induction, development, and integration of skilled personnel and administrators, there remains the important area of incentives. The issue of nonmonetary incentives is of major concern to all organizations.

We now recognize that man is a social being that is motivated by factors other than money. The economic factor cannot be eliminated but has to be tied together with social motivation and incentive. "Job enlargement" is a typical nonmonetary incentive based on the concept that a man takes pride in his work and desires to grow. Managerial responsibility should be broadened by eliminating the concept of control and substituting the concept of objectives, for setting objectives permits the use of initiative. Measuring instruments and control information should be given first to the man who has the responsibility, then, secondly, to his superior. This permits the individual with the responsibility to solve the probem and achieve the objectives.

Basic to incentive is that the individual's performance appraisal be an individual relationship between himself and his superior. His performance should be measured against the requirements of the job, not the man at the next desk. His own self-development program becomes in itself an incentive to better performance.

The Communications Problem

The foundation upon which every successful venture stands is good understanding between the people making up the organization. This understanding is based on good communications. Good communications uses every media, but the spoken word is by far the most important. Only with complete understanding among people can people work together effectively.

Good communications is a never-ending process. It begins the day the employee is hired and continues until the day he leaves the company. Good communications are aimed at:

1. Making the employee feel more secure in his job.
2. Making the employee feel he belongs.
3. Assuring the employee that the success of the company is his success and that the problems of the company are his problems.

Communications must flow in all directions; up, down, and sideways. Good communications within an organization are basic to the development of not only sound organization but also the human resources which are available within any organization. We must recognize that continually, through meetings, letters, bulletins, and the issuing of instructions, the communications process is at work for good or for ill in every organization.

To Order SP-319 . . .
. . . on which this article is based, turn to page 5.

Designing a Forged Steel Crankshaft . . .

. . . requires that a knowledge of the effects of modulus of elasticity and endurance limit on the design be known.

Based on paper by **Harold F. Wood,** Wyman-Gordon Co.

THE modulus of elasticity and the endurance limit of the crankshaft material have a major effect on crankshaft design if the proper bending rigidity and ratio of maximum allowable stress to the endurance limit of the material are to be obtained. The effect of these material properties on crankshaft design is shown in the following simple analysis of each.

Effect of Modulus of Elasticity on Crankshaft Design

The following simplified analysis shows how the modulus of elasticity of the crankshaft material af-

fects the required thickness of the critical section of the crankshaft throws. The bending rigidity of the critical sections is maintained by changing their thickness. Suppose a crankshaft is designed with the following:

d = Thickness of the critical section
b = Width of the critical section
I = Moment of inertia of the critical section
E = Modulus of elasticity of the material
M = Bending moment in the crank throw
L = Effective length of the crank throw as a beam

Bending deflection is proportional to:

$$\frac{ML^2}{EI}$$

and:

$$I = \frac{bd^3}{12}$$

Therefore bending deflection is proportional to:

$$\frac{12ML^2}{Ebd^3}$$

Suppose initial conditions are represented by letters having suffix "0" and new conditions with a lower modulus of elasticity by suffix "1." If M, L, and b are the same, the bending deflection remains the same if:

$$\frac{1}{E_0 d_0^3} = \frac{1}{E_1 d_1^3}$$

The new thickness of the critical section is therefore:

$$d_1 = d_0 \sqrt[3]{\frac{E_0}{E_1}}$$

Effect of Endurance Limit on Crankshaft Design

The following simplified analysis shows how the endurance limit of the crankshaft material affects the required thickness of the critical sections of the crankshaft throws. The ratio of maximum allowable stress to the endurance limit of the material in the critical sections is maintained by changing their thickness. It is assumed that the crankshaft is designed for the maximum allowable stress and that this is produced by bending in the crankshaft throws. Suppose a crankshaft is designed with the following:

d_0 = Thickness of the critical section
b_0 = Width of the critical section
Z_0 = Section modulus of the critical section
M_0 = Maximum bending moment occurring in the critical section
s_0 = Maximum allowable stress
p_0 = Endurance limit of the material

Then:

$$s_0 = \frac{M_0}{Z_0}$$

and:

$$Z_0 = \frac{b_0 d_0^2}{6}$$

Therefore:

$$s_0 = \frac{6M_0}{b_0 d_0^2} \qquad (1)$$

Now suppose the maximum allowable stress is reduced to s_1 but the maximum bending moment in the critical section remains the same. Then the section modulus has to be increased, say to Z_1. Suppose the new conditions are represented by letters having suffix "1."

Then:

$$s_1 = \frac{M_0}{Z_1}$$

and:

$$Z_1 = \frac{b_1 d_1^2}{6}$$

Again:

$$s_1 = \frac{6M_0}{b_1 d_1^2} \qquad (2)$$

Since we are going to compensate for the reduction in maximum allowable stress only by increasing the thickness of the critical section, then:

$$b_1 = b_0$$

So dividing equation 1 by equation 2:

$$\frac{s_0}{s_1} = \frac{d_1^2}{d_0^2} \qquad (3)$$

Taking the maximum allowable stress to be some fixed proportion of the endurance limit of the material:

$$\frac{s_0}{p_0} = \frac{s_1}{p_1}$$

or:

$$\frac{s_0}{s_1} = \frac{p_0}{p_1}$$

Combining this with equation 3:

$$\frac{p_0}{p_1} = \frac{d_1^2}{d_0^2}$$

The new thickness of the critical section is therefore:

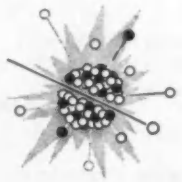
$$d_1 = d_0 \sqrt{\frac{p_0}{p_1}}$$

Some improvement can be made in the properties of the critical section by increasing the width by using oval contours. Reference to the formulas for moment of inertia and section modulus shows that such additions are much less effective than increasing the thickness.

This is part of an article which originally appeared on pp. 23–25 of the June SAE Journal. This part contained a number of erroneous equations in the original, which have been corrected in this rerun.

To Order Paper No. 13 . . .
. . . on which this article is based, turn to page 5.

A feature from the



SAE Nuclear Energy
Advisory Committee

Tough Problems by Fusion

Reported by

Dr. Clayton R. Lewis

chairman, SAE Nuclear Energy Advisory Committee

POWER generation by fusion reactions (the nuclear reactions that take place when an H-bomb explodes and that are responsible for the energy output of the stars) is now being studied with considerable attention.

Scientists have found, however, that formidable difficulties stand in the way of developing practical fusion reactors, such as:

1. Producing the exceedingly high temperatures (hundreds of millions of degrees) required to give the particles sufficient energy for the fusion reactions to occur.

2. Making the reaction self-sustaining like a fission chain-reaction—that is, keeping the device at a temperature at which the system will remain in a steady state and not cool off.

3. Providing adequate confinement at such temperatures for a sufficiently long time so that an appreciable fraction of the nuclei can undergo fusion.

Many years of intensive research will be required to solve these problems, so that this type of reactor is not going to replace the fission reactors now being built, for many years to come.

It does appear, however, that fusion reactors may well be our main source of power in the future for, if fusion reactors can be controlled satisfactorily, our energy sources will be almost inexhaustible. It is estimated that the oceans contain enough heavy hydrogen, which is one of the materials entering into fusion, to provide energy at our present rate of consumption for many millions of years.

High Temperatures Needed

For fusion reactions to occur, it is necessary to have the particles in a confined region, and moving at high velocities with respect to one another. This corresponds to having deuterium at temperatures of 100 million degrees or more—temperatures, higher than those in the interior of the sun, which will vaporize all materials.

Only extremely light elements—those of low atomic number—can be considered as possible fuels in fusion reactions. Part of the reason is that the force of repulsion increases with the atomic number of the interacting nuclei—representing the number of positively charged protons in each nucleus. Hence, the temperature required to overcome these forces of repulsion increases very appreciably with the mass number of the element. It is for this reason that the isotopes of hydrogen are particularly interesting. Other elements with higher atomic numbers are not out of the question as possible fuels, but they would require even higher temperatures.

Making the Reaction Self-Sustaining

The plasma or ionized gases that exist at these extremely high temperatures radiates energy at a very appreciable rate. No isolated plasma can remain at a high temperature if it gives off energy faster than it generates it. Under conditions of practical interest, when the temperature is increased, the rate of nuclear reaction rises more rapidly than the rate of radiation. Accordingly, there is a minimum temperature below which the reaction cannot sustain itself by generating more internal energy than it radiates. This so-called "ignition temperature" turns out to be independent of the density of the plasma. For the deuterium-deuterium reaction this temperature is 400 million degrees. For the deuterium-tritium reaction it is somewhat lower.

Confining the Plasma

Since no materials can stand up to these enormous temperatures, the use of magnetic fields is being studied to confine the plasma and prevent it

Hinder Power Generation Reactions

from vaporizing the walls of the reaction chamber.

The magnetic field will change the normally straight paths of the charged particles of the plasma into tight spirals. The particles will then move down the magnetic lines of force in a path similar to the spiral stripes on a barber's pole. The only way, then, in which a charged particle can move outward toward the container walls is through colliding with other particles.

The collision shifts the instantaneous center of curvature of the particle's path. A strong magnetic field greatly reduces the diffusion of particles across the field. Roughly, they act as if they were tied to a line of force of the magnetic field. However, motions of particles along the lines of magnetic force are not impeded, and special techniques must be invoked to prevent loss of particles from the hot region in this way. One method of preventing this loss of particles is to produce an endless discharge in a Perhapsatron, which is a doughnut-shaped tube in which ionized gas reactions are performed.

When magnetic force lines are employed as barriers against the escape of the plasma, pressure is built up inside the magnetic lines and the force walls imprisoning the plasma may become unstable. The force lines behave much like rubber bands around a rubber balloon. That is, they tend to bend inward and let the plasma flow out around them. This phenomenon presents one of the big difficulties, and scientists in the program are searching for an adequate solution.

New Development in Fission Reactors

In the meantime, studies relating to fusion reactions have apparently inspired designers of fission reactors. A new conceptual design has recently been released in which the nuclear fission reactions take place in a high-temperature gas—the temperature sufficiently high so that the gas is largely ionized. Its movement in the reactor is used to interact with a magnetic field to produce electric power directly from the nuclear reaction. Order of magnitude estimates indicate that the minimum size of a reactor of this type would have electric power output of the order of 5000 kw, and would operate at an overall efficiency of about 20%. In addition, conventional heat engines could be operated from the same reactor, since the reactor core must operate at a temperature of several thousand degrees.

World Standardization

A START toward world standardization for peaceful use of nuclear energy was taken recently by ISO Technical Committee 85 on Nuclear Energy. The committee outlined six areas of work for itself, as follows:

1. A trilingual glossary of terms.

2. A warning symbol for use wherever danger from ionizing radiation is present.

3. Adoption of units pertaining to nuclear energy developed by the International Commission on Radiation Protection and the International Commission of Radiological Units.

4. Development of symbols required for drawings.

5. Recommendations relating to measurement of radiation and protection against radiation.

6. Guides for safe design, operation, and maintenance of nuclear reactors.

This committee met for the first time during the July 29–August 1 convention of the International Organization for Standardization, held in Geneva, Switzerland. The United States holds the secretariat of the committee through the ASA. Its chairman is Morehead Patterson, president and chairman of the board, American Machine & Foundry Co.

Measuring

Based on paper by

Frank Herzegh,

B. F. Goodrich Co.

GOODRICH has developed a method for measuring tire thump and roughness which gives values correlating closely with those obtained from the field. It meets four requirements which make it satisfactory for passenger-car tire production purposes. These are:

1. Measurement of the actual thump, that is, the thump which causes consumer complaint and which is not due to unbalance of the wheel and tire assembly.

2. Reproducibility.

3. Easy interpretation of data.

4. Practicability and dependability in basic apparatus design.

For the test apparatus, a Cadillac frame complete with original front suspension was set up with the rear half of the frame cut off and attached to pivots. Shock absorbers are attached from the front of the frame to the floor to damp frame oscillations.

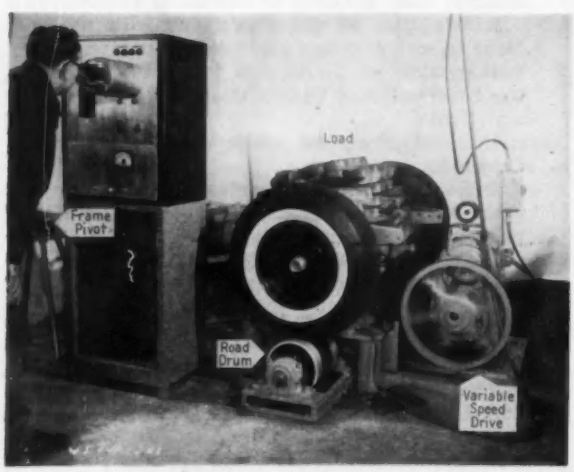


Fig. 1—Tire thump test apparatus showing speaker transducer mounted in position under suspension. In operation, a fluid container would replace beaker and speaker diaphragm would be immersed in oil to be damped against resonance.

A velocity sensitive transducer, actuated by vertical movement of the suspension, is used to produce a signal indicating the severity of the thump or roughness. This is an ordinary 5-in. round mass-produced permanent magnet speaker. A light, rigid bar is attached to the frame of the speaker, the upper end being fastened to the A-frame of the suspension as close as possible to the wheel. A discarded speaker frame is used to support the active speaker. A container with oil is positioned under the suspended speaker so that the diaphragm is immersed in oil to a depth of about 3 in., thus damping the diaphragm against resonance. SAE 30 viscosity oil is used, but presumably other viscous fluids could be used. The oil container is mounted solidly on the floor so as to be free of vibration.

The speaker is shown mounted under the suspension in Fig. 1. Here a beaker has been substituted for the usual fluid container and the oil omitted to give a clear illustration.

Any movement of the speaker frame (magnet) results in a movement of the coil attached to the diaphragm relative to the magnet, and a signal voltage is thus generated of a magnitude proportional to the velocity of movement of the A-frame. The signal from the transducer can be amplified by any number of commercially available amplifiers having flat frequency amplification characteristics ranging from d-c, or at least down to about ½ cps, up to a few hundred cps. The amplifier should have a calibrated voltage source for adjusting the gain of the amplifier to a standard value. The signal may be displayed by coupling it to some form of output meter, an electromechanical oscillograph, or a cathode-ray oscilloscope. The meter is not a reliable guide because the intensity of the varying thump signal is averaged; the electromechanical oscillograph provides an accurate display of the signal but it is hard for an untrained person to interpret.

The cathode-ray oscilloscope is satisfactory in all respects. Use of a polar sweep seems to simplify interpretation, as the circular trace fits nicely with the concept of a tire. The current design has a magnetically deflected cathode-ray tube with a mechanically rotated deflection yoke. A long persistence (No. 7 or 14 phosphor) screen cathode-ray tube is used to provide a visually stable image. The yoke is driven from the wheel hub by hub-mounted and take-off gears turning a flexible shaft drive with an overall 1 to 1 ratio between deflection yoke and wheel hub. Phase adjustment between the image and the tire is provided by gear mesh changes with controls on the oscilloscope panel. A 35-mm camera of the single-lens reflex type is mounted permanently before the cathode-ray tube, permit-

Tire Thump for Quality Control

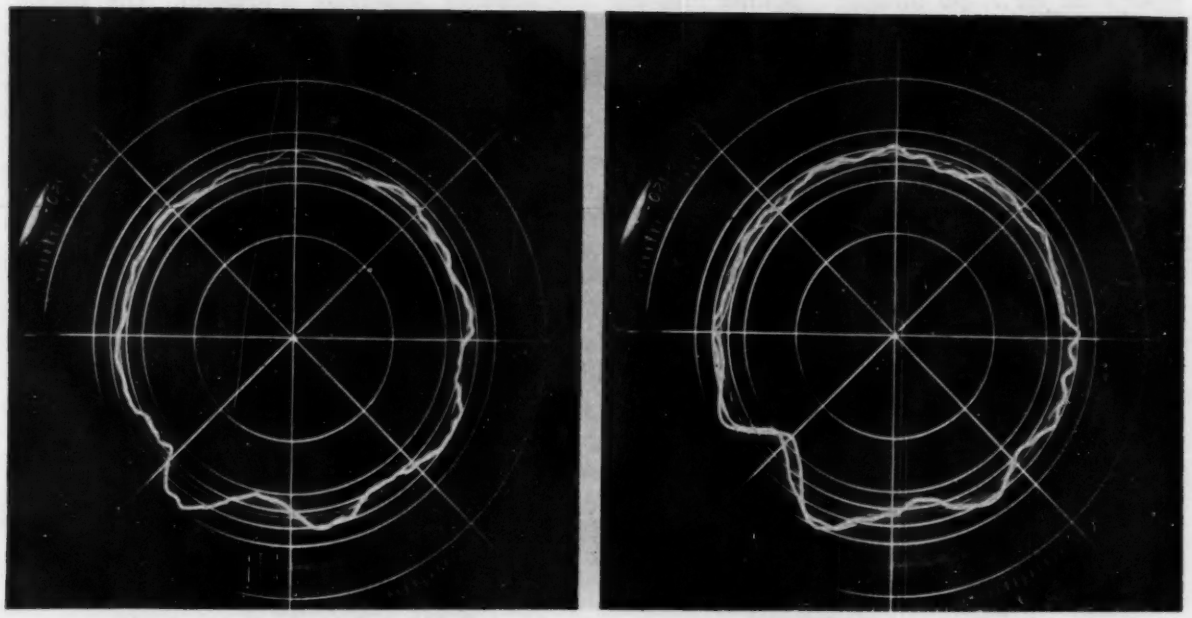


Fig. 2—Traces of thumping tire run at (left) 12 mph and (right) 17 mph. Traces are reasonably consistent with speed variations between 10 and 17 mph.

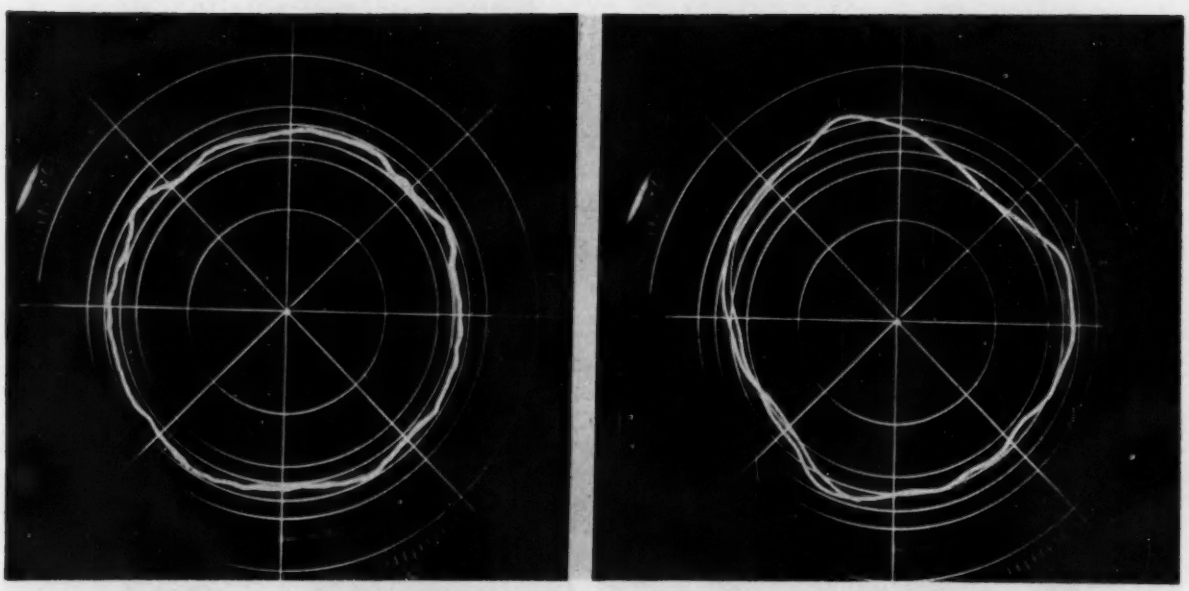


Fig. 3—Tire which rates thump-free on road test and on bench test with a speaker transducer (left) may get a very poor rating (right) with a differential transformer type of displacement measurement transducer.

ting direct visual examination of the image and, if desired, a photographic record is at hand.

Test Procedure

Tires are mounted on conventional rims, although rim width is not critical. Radial or lateral run-out of the rims is not critical within several times the commercially accepted limits. Inflation pressure of 35 psi is used for all tire sizes and loads are approximately those recommended by the Tire & Rim Association for 22-psi inflation. Neither inflation pressure nor load is critical within wide limits, but speed of rotation is.

Since road thump is usually discerned as a one cycle per unit wheel rotation disturbance, a thump closely coincident with suspension resonant frequency results in exaggerated and erratic suspension oscillation. For this reason, the wheel is run at thump developing frequencies considerably below the suspension resonant frequency. For all sizes of passenger-car tires a wheel speed of 4 rps is used, corresponding roughly to 17-mph road speed. The resonant frequency of the test suspension is about 21 cps.

The tire, mounted on the wheel of the test chassis, is positioned so that some identifying mark on the periphery is directly over the road drum. The oscilloscope face has a screen indexed from 0 to 360 deg and with radial lines at 45-deg interval. The electron beam is set to spot on 0 deg before wheel rotation begins so that there is a fixed relationship between engagement of road wheel and tire and a corresponding spot on the circular trace of the oscilloscope screen, thus identifying the angular location of all disturbances signaled from the tire. A series of concentric circles on the screen aids in estimating the magnitude of the radial disturbance of the image.

Results of Thump Test

Traces of a thumping tire run at speeds of 12 and 17 mph are shown in Fig. 2. The trace is reasonably consistent with speed variations between 10 and 17 mph.

Many tires which are perfectly free of thump disturbance may give a poor showing when tested on a displacement measuring instrument. The poorest tires would be in agreement, of course, with the displacement data on road tests, while the satisfactory and excellent tires would be unjustly condemned. This is illustrated by the traces shown in Fig. 3.

Tires do not change quickly on being put into normal service. Traces made of tires before use and after 1000 miles service show very little change in performance and thus indicate the reproducibility of the test method.

A form of thump may be associated with high road speeds due to unbalance of the wheel and tire assembly, but such unbalance does not influence the test result to any appreciable degree. This is shown in Fig. 4, where the test result of a tire free from thump and correctly balanced is compared with a test of the same tire unbalanced by the addition of wheel weights to throw the balance out by 150 in.-oz.

From test experience it is concluded that tire thump should be thought of as a sensation experienced by the car driver, which sensation the laboratory seeks to correlate with a measurement of something on the tire, rather than as a tire characteristic to be measured in the laboratory.

To Order Paper No. 124 . . .
. . . on which this article is based, turn to page 5.

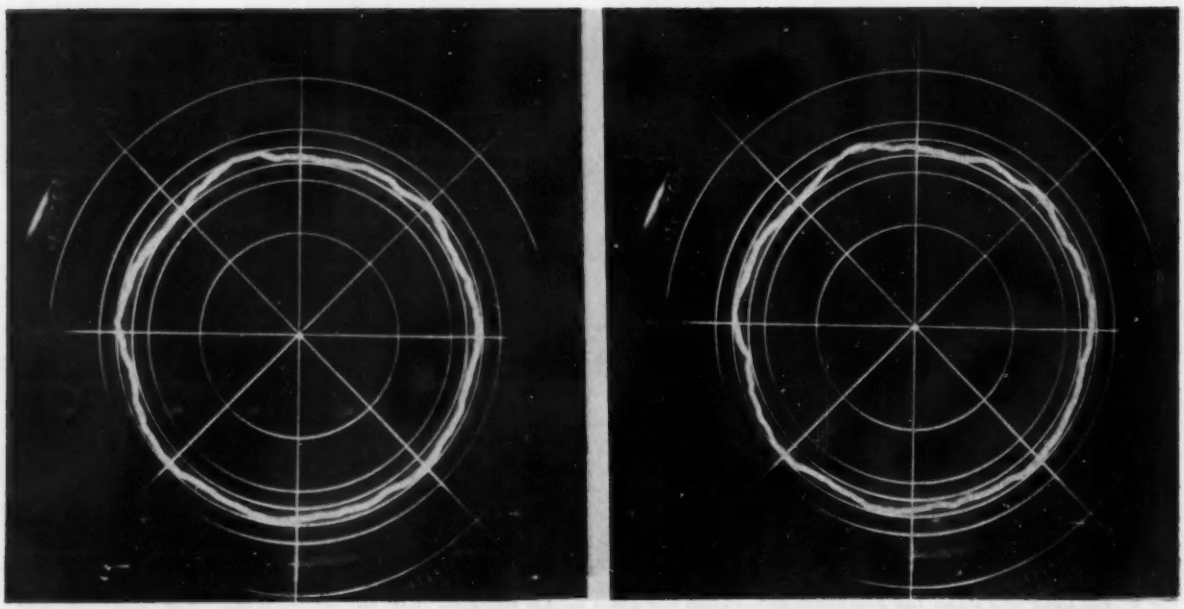


Fig. 4—(Left) trace of a tire free of thump and correctly balanced. (Right) same tire thrown out of balance 150 in.-oz by wheel weights.

SAE LOOKS OVERSEAS

by JOSEPH GESCHELIN *Detroit Editor, Chilton Publications*

Based on visit to Nissan Motor Co. of Yokohama on a recent trip to the Orient.

Japan's motor vehicle industry is moving in high gear, aided to an important extent by recent orders for Jeeps and heavy-duty vehicles by the U. S. Armed Forces as part of the off-shore procurement program. Passenger car producers are faced with a unique problem. The masses of the workers, unlike the situation in the U. S., cannot afford to buy a car - either new or used. Hence, motor car production is channeled for taxicab use and for export.

JAPAN EXPORTS CARS

There has been talk of exporting Japanese cars to the U. S. to cash in on the wave of small car buying. Nissan Motor Co.is now in the process of expanding and revamping its manufacturing and assembly facilities in Yokohama incident to the release of buildings and land area by the Occupation Forces. They also hinted that a new car design is being considered to replace the current Datsun which has been in production since about 1933. This might be the kind of vehicle that would be exploited on the U. S. market.

TRANSFER MACHINES USED AND BUILT

It is very significant that Nissan has in operation four transfer machine lines, designed and built by two Japanese machine tool manufacturers. In appearance, these transfer machines compare with anything of equal size to be found in Detroit. Three of these machines are tooled for cylinder blocks, the other handles cylinder heads. We were given to understand that Nissan has pioneered the use of transfer machines in their industry.

The important thing is that the combination of advanced manufacturing techniques and extremely low labor rates - by comparison with rates prevailing in the U. S. - could make Japanese cars very competitive in our market.

HORNS HONK IN JAPAN TOO

Japanese highways,such as they are, are crowded incredibly with a profusion of trucks, thousands of taxicabs, interspersed with motorcycles and bikes. It defies any attempt at description since even our conception of bumper-to-bumper traffic fails to paint the picture. Incidentally, all of this traffic moves entirely by honking horns. The varied sounds of horns fill the air on the highways and on the streets of Tokyo.

This feature is an activity of the SAE OVERSEAS INFORMATION COMMITTEE, C. G. A. Rosen, chairman

CRC in '57

The Coordinating Research Council's activities for the past year are summarized in the accompanying article, which is part of the CRC Annual Report for the year ending June 30, 1957.

CRC activity in the automotive, diesel, and aircraft fields has continued to increase during the past year. In the aircraft field, in addition to an increase in the number of projects being carried on cooperatively, there has been a definite speeding up of test programs. In the diesel field, preliminary work has been started which it is expected will result in an extensive program to study the evaluation of diesel-engine lubricating oils. In the passenger-car area, the trend to higher compression ratios and higher antiknock fuels has raised problems associated with the significance of the current methods of evaluating fuel quality in this new area. The development of new engines has also brought out the need for study of problems such as valve and tappet wear problems and lubrication under low-temperature city-driving conditions.

There has also been an increase in the work that CRC has been doing for the Military Services, although not of the same magnitude as that for industry. During the war years, CRC was putting almost 100% of its effort on military problems. This was dropped right after the war and rose again during the Korean emergency to approximately 65%, and since then has stabilized at about 40% of our effort. In view of the unsettled conditions in the world, and the rapid pace with which our Military Services are moving, it is anticipated that this general level of interest and support by the military will continue for some time into the future.

The shortage of technical manpower continues to be a serious problem and is one of the important factors which is considered upon the initiation of all CRC projects. The CRC Assignment Committee has the responsibility of reviewing critically all CRC projects, not only new projects being proposed for CRC work, but also those currently under way, to insure that only those which are of vital importance to the petroleum and equipment industries or to the Military Services are carried forward. In a number of instances, it has been possible to establish CRC advisory groups which have the responsibility of directing research programs being conducted by the Military Services themselves. In other instances, detailed research programs have been developed by the CRC groups, and commercial and university laboratories have been selected to carry out the research work under contract to the CRC. By using this advisory group technique, it has been possible to carry on research projects which could not have been undertaken under the normal pattern of dividing the laboratory test program among the cooperating laboratories.

The CRC is currently working on 51 individual projects, dealing with 32 separate subjects. During the past year, work was initiated on five individual projects, representing two new subjects, and an amplification of one subject, as well as two projects which are carried out on an annual basis. Work on seven projects has been completed, or completed except for the release of a final report, since the issuance of the 1956 Annual Report.

CRC technical reports, prepared during the progress of work or upon completion of a project, are

released by the appropriate CRC Committee to the Sustaining Members for publication or general distribution. An arrangement has been made with the American Petroleum Institute and the Society of Automotive Engineers, Inc., for distribution of released reports. Lists of all available CRC reports are published periodically in the SAE Journal.

A short review of some of the projects being carried on by the Coordinating Fuel and Equipment Research Committee and the Coordinating Lubricant and Equipment Research Committee is given below.

Fuel and Equipment Research

Under the direct supervision of the Coordinating Fuel and Equipment Research Committee, work is progressing on two projects to measure instantaneous combustion temperatures in spark-ignition engines. One of these is a sound-velocity technique type of measurement, which is being carried out at the Massachusetts Institute of Technology, and the other, an iodine absorption technique type of measurement, being carried out at the University of Wisconsin. Detailed reports are received periodically from these universities. Test results from the universities have demonstrated that both temperature measurement techniques are satisfactory. The sound-velocity technique has also been demonstrated to be applicable to the study of the effect of operating variables on end-gas temperatures, and to the effect of variables on temperatures during the compression process. The iodine-absorption technique has also shown that temperatures can be measured; however, a simpler technique utilizing infrared absorption has shown that it can be more useful in actual laboratory use. The work is being guided by a special CFR advisory group, and it is planned to continue the work at the two universities to permit the development of the sound-velocity instrument into a form more useful in industry laboratories, primarily to permit its use in the combustion chambers of commercial multicylinder engines, and also to provide for a crosscheck on temperature measurements by two fundamentally different techniques.

The work of the CFR Fuel Storage Stability Group, which was requested by the Office, Chief of Ordnance, consists primarily of a long-range fundamental study of gum formation being carried out, under military contract, by the U. S. Bureau of Mines, Bartlesville, Okla., and the Stanford Research Institute, Palo Alto, Calif. The basic objective of the program set up by the Bureau covers the development of relationships of motor gasoline stability, including both preformed gum and induction-system deposits, to the several parameters that may affect stability. These parameters include composition of the gasoline, temperature, oxygen availability, and catalysts. The immediate objective of the Stanford Research program is to obtain fundamental information on the chemistry and chemical kinetics of the formation of objectionable gum and haze in gasoline. The long-range objective of the program is to develop information to permit establishing new techniques for predicting the stability of motor gasoline. It is expected that radioactive-tracer techniques will be used in this work. It was recognized at the initiation of the project that the fundamental study of stability would be a long-term program. However, the members of the CFR advisory group have expressed their satisfaction with the progress that has been made by the two organizations, and it is expected that information of real value to the cooperating industries and to the Military Services will be available in the near future.

The CFR Group on Composition of Exhaust Gases has been extremely active during the past year in studying the composition of exhaust gases from automotive vehicles. Their work has included a study of the techniques used in the sampling and analysis of exhaust gas, and the effect of engine, operating, fuel and lubricant variables on exhaust gas composition, as well as the carrying out of a comprehensive field survey of the emissions of vehicles as they are used.

It is expected that a report on the activities of this group will be prepared this fall for transmittal to the CFR Committee, and shortly thereafter this report should be released to the Society of Automotive Engineers and the American Petroleum Institute. The report will include descriptions of a number of satisfactory techniques for analyzing exhaust gas emissions from spark-ignition engines for carbon monoxide, carbon dioxide, total hydrocarbon content, and oxides of nitrogen. Grab sampling techniques and continuous-reading infrared spectrographic techniques will also be described. These techniques have now been worked out, but refinements will undoubtedly be made during the remainder of the year. The effect of engine and operating variables on exhaust gas composition will also be described. The operating conditions include acceleration from 0 to 35 mph at full throttle, and also at some part-throttle conditions; deceleration from 50 to 20 mph, freely coasting, and with the use of brakes; and steady-load conditions, such as cruising at 30 mph.

The usefulness of these techniques and the importance of operating variables have been confirmed by a full-scale survey of approximately 300 cars. This survey required a total of approximately sixteen men, in addition to non-engineering personnel, such as drivers and mechanics. During the test program, approximately ten miles of oscillograph tape were taken, and the test data have been transcribed onto over 200,000 IBM cards, requiring more than 100 machine-hr for the preliminary analysis.

The work on composition of exhaust gases has revealed the need for the development of new techniques for the identification of individual components within the gas. One of the most promising of these is the use of gas chromatography. An 18-month contract was initiated with the Bureau of Mines, where considerable experience had been gained in the field, covering the development of techniques employing gas and gas-liquid chromatography specifically for the analysis of exhaust gases. The first 18 months of research have resulted in the development of a technique for the identification of individual hydrocarbons in the C_2–C_7 range. The project will be extended for a 12-month period to extend further the range of the technique to include both methane and hydrocarbons in the C_7–C_{10} molecular-weight range, and also to identify the oxygenated constituents of the exhaust gas in order that the true nature of the problem can be recognized.

At the request of the Office, Chief of Ordnance,

the CFR Committee has established a special group, the members of which are preparing an outline for a booklet to be used by the Ordnance Corps to assist the designers of Ordnance materiel in understanding some of the problems involved in the mutual adaptation of fuels, lubricants, and the equipment in which they are used. It is expected that the Ordnance Corps will arrange for the printing and distribution of this booklet after the outline has been approved by the CFR Report Review Group.

The CFR Aviation Fuels Division has been particularly active during the past year in connection with fuel-system studies. One of these is the project dealing with the thermal stability of aviation gas turbine fuels at high rates of flow and at high temperatures. The primary objective of this project is to develop a research technique to evaluate the deposit-forming tendencies of aviation gas turbine fuels of all types, such as kerosene, JP-4, and JP-5, in fuel-cooled heat exchangers and in the fuel system following the heat exchangers. A test apparatus has been developed, and a number of units have been constructed and used to evaluate the deposit-forming tendencies of a series of test fuels on which full-scale performance test data were available. A report covering this work has been prepared which describes the technique and gives data indicating the degree of correlation between the laboratory technique and full-scale results. An exchange program has been set up by which the cooperating laboratories will test common fuels each month to assist in establishing the reproducibility and repeatability of the technique. It is expected that the American Society for Testing Materials will take over the standardization of the test, while the Coordinating Research Council will continue to work on the further development of a technique in the higher-temperature ranges, and with different types of fuels.

A second project on the handling of fuel within modern high-speed aircraft concerns the accumulation of data on air-gas solubility at very high rates of flow. A research program on this subject is being carried out by the Atlantic Research Corp. under the guidance of a special CRC advisory group. This work covers the determination of the rates of solution and gas evolution from aircraft fuels in agitated tanks and fuel lines. The range of variables to be explored will be large enough to permit the proper design of prototype equipment. The results are to be correlated in such a way as to facilitate the design and scale-up of equipment. The final report will include pertinent information found in literature, mathematical and theoretical relationships, experimental results, correlations of data, design and scale-up equations and graphs, and all pertinent discussions. The program will take 15 months to complete, at a direct cost of $80,250, which, together with CRC overhead costs, is being supported by an Air Force contract. It is anticipated that the results should permit the establishment of design criteria for aircraft fuels and vent systems to handle adequately gas and vapor under dynamic conditions.

The third project on aviation fuels and systems concerns the development of an Aviation Fuels Handbook. Broadly speaking, the airframe industry urgently desires CRC to bring up-to-date the aviation fuels section of the 1946 edition of the CRC Handbook, and to incorporate the information on the properties of aviation fuels which would be of assistance to fuel system designers. Design information of a general nature, covering a wide range of fuel characteristics, including recent CRC data on volatility, water content, and the like, will be included. Information secured not necessarily only as a result of CRC projects, but other data useful in connection with fuel system studies, will be assembled. Sample data sheets have been prepared and approved, and the collection of data and reduction of these data to summary form is under way.

The CFR-AFD Turbine Combustion Group has not been active during the past year, primarily because of the press of work on the other aviation fuel problems. During the latter part of the year, it has become evident that there is an industry need for a technique for evaluating in the laboratory the combustion characteristics of aviation gas turbine fuels that is more significant in reference to full-scale operation than the currently used smoke lamp or smoke-volatility index. It is expected that activity in this area will be initiated during the next year.

The CFR Aviation Fuels Division has initiated a program of research in the field of electrical discharges in aviation fuel systems at the request of the aviation industry. Explosions of fuel vapors in tanks and handling equipment by electrical discharge has been experienced in the petroleum industry. The evidence indicates the igniting discharges can be generated within or by fuels flowing through piping or other equipment, and that fuel differences, as well as the equipment design, can influence the frequency of discharge. Unfortunately, the state of the art lacks ability to predict the existence or degree of hazard which may exist under a given set of conditions. This lack of knowledge has become of real concern in the case of jet gas turbine powered aircraft, including commercial transports. This program is, therefore, proposed to determine:

1. What factors control the development of electrical discharges within aircraft fuel systems.
2. Under what conditions do such electrical discharges constitute a safety hazard.

It is planned that the work outlined shall be carried on by industry participation in a cooperative study, part of which is to be carried on at the fuel system facility at Wright Air Development Center, and the remainder in the laboratories of the cooperating companies.

The CFR Diesel Fuels Division has been actively working with the U. S. Navy Bureau of Ships on a study of the deposit-forming characteristics of diesel fuels, and has been carrying out work on a number of industry projects, such as determinations of ignition quality of diesel fuel, an evaluation of smokemeters, and the compilation of full-scale test techniques.

The CFR Diesel Fuels Division has been acting in an advisory capacity with the U. S. Navy in connection with the problems associated with the main propulsion engines in submarines. Members have

assisted in the development of an improved rating scale, and are acting in an advisory capacity in programming and scheduling test runs. The work is being conducted by the Navy on a 16-cyl GMC Cleveland 278A engine. A series of fuels and lubricating oils has been tested in longtime tests under simulated snorkel conditions. The tests have shown that the use of high-additive-content lubricating oils will permit the use of high-sulfur-content fuels, such as might be available during emergency conditions. The engine wear is relatively low, and deposits in the engine are at a low level, but excessive valve burning does occur. Design changes to alleviate this latter condition are being studied.

The study of the significance of the current laboratory techniques for the determination of diesel-fuel ignition quality is continuing, with particular emphasis on starting, warmup, and operation under variations of speed and load.

A compilation of general techniques for full-scale diesel-engine testing is being prepared under the guidance of the CFR Fuels Division. The performance characteristics of diesel fuels and engines which are covered by the evaluation techniques in this compilation include cold starting and warmup, full-scale railroad field service testing, and deposit formation and wear techniques in high-speed diesel engines.

It has become evident during the past few years that improvements were needed in the method for measuring smoke in the exhaust of diesel engines. Improvements in the photoelectric type of smokemeter are being studies, along with an evaluation of the continuous-recording filtering smokemeter. It is felt that, rather than there being one type of meter which is best under all conditions, each of these types of meters may have advantages under certain conditions.

The current work of the CFR Motor Fuels Division covers investigations of surface ignition, a field survey of octane-number requirements, a detonation road-rating exchange, a study of the combustion characteristics of very high octane-number fuels, the importance of volatility, and the development of a technique to predict the vapor-locking tendencies of fuels, and a fundamental study of the various expressions for fuel knock rating.

The members of the CFR-MFD Combustion-Chamber-Deposits Group have been very active in their study of the surface-ignition problem. The first phase of the work has been concentrated on the standardization of terminology, a review of the various types of surface-ignition instrumentation, and a study of possible reference fuels for surface-ignition work. Excellent progress has been made in this project. A standardized terminology has been recommended, and released to industry. A number of reference-fuel systems have been studied, and extensive test data have been obtained. Instrumentation techniques have been developed for use in multicylinder engines, as well as laboratory single-cylinder engines.

Determining the octane-number requirements of passenger cars as operated in the hands of the public has been an annual project of the CFR Motor Fuels Division for some time. During the past few years, emphasis has been placed on the statistical study of the octane-number requirements of new-design engines and transmissions. The 1957 program will also follow this pattern. Approximately 600 cars of 17 different models will be tested, using both primary and full-boiling-range reference fuels.

In addition to obtaining the octane-number requirements of passenger cars on the road, another activity of the CFR Motor Fuels Division has been the study of rating of motor fuels in motor vehicles on the road. The program being currently studied by this activity is the effect of fuel sensitivity on road ratings. A series of test fuels varying in sensitivity at a number of octane-number levels has been made available to the cooperating laboratories.

The increased interest in the rating of motor fuels in the high antiknock range has also increased interest in a study of the interrelationships of the various knock-test techniques and knock performance of full-scale vehicles. Test programs are being carried out with a series of fuels of varying sensitivity in a series of full-scale multicylinder engines to improve our understanding of the knock phenomena as it is affected by fuels, and also to investigate the validity of the temperature-density concept of knock.

One of the new subjects being studied by the CFR Motor Fuels Division is that of the evaluation of the antiknock quality of high-octane-level fuels. A number of companies has indicated that current techniques for measuring antiknock quality of fuels are not adequate for determining the true antiknock value of individual components of motor gasoline, particularly in the range of isooctane + 0.5 ml tel. This is particularly noticeable when trying to evaluate the antiknock quality of aromatic or olefinic materials, or blends containing high percentages of these materials. A symposium was held during the fall of 1956, where individual organizations presented information on this subject. It was pointed out that the problem is not that of repeatability or reproducibility of the antiknock determination, as much as that of a better understanding of the combustion characteristics of high antiknock fuels, particularly those containing aromatic or olefinic compounds. As a result of this symposium, the CFR Motor Fuels Division has formed a group to study this problem. Considerable test data have been made available, indicating the interest of the automotive and petroleum industries in this problem.

The subject of fuel volatility is one of the most active projects being carried on by the CFR Motor Fuels Division. One objective of the Volatility Group has been the establishment of an expression for volatility as related to vapor lock which will have greater significance with relation to the vapor-lock performance of fuels than the currently used Reid vapor pressure method. As a first step, the Panel chose a series of 10 fuels, varying in volatility characteristics, vapor pressure, and slope of the front-end of the distillation curve, and requested a number of companies to line up the fuels in accordance with the expression of fuel volatility they individually used in predicting vapor-locking tendencies of fuels. The Panel members then took the various expressions, and developed correlation factors based on Reid vapor pressure and other physical characteristics, lining up the fuels in relation to the ranking the individual companies would give them, based on their tendency to vapor lock. On the basis of limited investigations, three of these expressions appear to

have greater significance than the Reid vapor pressure method. A number of laboratories has conducted vapor-lock test programs, and made the results of these programs available to the CFR Motor Fuels Division for a further evaluation of these various expressions. For the first time since 1948, a vapor-lock survey of passenger cars will be conducted in 1957. This survey, which is designed to assess the vapor-handling characteristics of the current 1957 model passenger cars, will also provide data which can be used in the study of the various expressions for fuel volatility.

Last year, the CFR Motor Fuels Division was very active in the work of the extension of the octane scale, and a new formula for expressing antiknock ratings of motor fuels above 100 octane number was evolved, and after approval by the CFR Committee, was released to the Society of Automotive Engineers and the American Petroleum Institute. This formula has subsequently been accepted by the American Society for Testing Materials and is now in fairly widespread use by both the petroleum and automotive industries.

Lubricant and Equipment Research

The major activity of the CLR Aircraft Lubricants Division covers research on the problem of the mutual adaptation of airframe lubricants and equipment. The work on rust-preventive properties of greases has been completed and a report which will include the recommended research technique for the evaluation of this property of greases is being prepared for release to the Society of Automotive Engineers and the American Petroleum Institute and also to the American Society for Testing Materials. The high-temperature operation of antifriction bearings is being continued at temperatures in excess of 450 F. One phase of this activity is the study of test equipment operation in the range of 750 F. At the request of the airframe industry, the study is being extended to cover the evaluation of these bearings under loaded conditions, as well as running without load. The work on high-temperature testing of miniature electronic-system bearings is continuing, as is work on screw thread and gear mechanisms. The activity in the field of solid-film lubricants is developing. Arrangements have been made for the preparation of a series of test pieces with coatings representing poor, intermediate, and good experience to permit the evaluation of various designs of test equipment.

During the past year, the first phase of the development of the CLR Oil Test Engine has been completed. A technique for evaluating the high-temperature oxidation characteristics of lubricating oils, designed to replace the Chevrolet L-4 test, has been developed and approved by the CLR Committee. As is true with any new technique, there are a number of places which can stand improvement, and this work is being carried on, but in its present state, the new test technique, designated as CRC Research Technique L-38, is as good as the L-4 test and has promise of being a better test. The Ordnance Corps has asked the petroleum suppliers submitting oils for qualification to include L-38 test results where possible, so that a background of experience can be developed. It is expected that, if the current series of L-38 tests confirm the expectations of the Group, the Ordnance Corps will make the L-38 an alternate to the L-4 for qualification of military oils.

A second use of the CLR Oil Test Engine is being studied—that of evaluating the moderate-duty varnish and sludge-formation characteristics of lubricating oils. A number of laboratories is conducting preliminary tests, and the engine seems to be able to indicate differences between oils in this regard. The study of deposit-forming characteristics of engines and lubricating oils is continuing. The ability to reproduce in the laboratory the same type of deposits as those found in the field has been the objective of this study. There has been considerable success in attaining this objective. Additional field service data are required to permit correlation of laboratory engine tests with field service. The Ordnance Corps is conducting an 18-month field test on approximately twenty new V-8 and 6-cyl passenger cars under moderate, or light-duty service for the CLR Group. This information will also be correlated with the CLR Oil Test Engine results.

A very comprehensive and extensive field test program designed to study the problem of camshaft and valve-tappet wear and corrosion was carried on by the CLR Engine Lubricants Division. Field service tests, in which about 300 vehicles of 10 different makes were run, using four different experimental lubricants, under a variety of operating conditions, have been completed. Upon completion of the tests, the participants determined the wear of the significant parts, and that data, plus significant information regarding operating conditions and similar items, were the basis of a CRC report which was released early this year. A paper on this program was presented to the Society of Automotive Engineers. A review of the test data in comparison with the laboratory engine test data made available by a number of the cooperating companies indicated that no one test was significant in predicting service performance of different lubricant and metallurgical combinations. It is planned to review with the equipment industry whether or not the problem as it exists this year is sufficiently acute to insure that the necessary laboratory time and manpower would be made available if a further cooperative test program was to be initiated.

The CLR-ELD Railroad Engines and Their Lubrication Group has been developing information by means of a questionnaire to "determine the mutual interdependence of different types of lubricants and different types of railroad engines under a variety of operating conditions, recognizing the mutual effect of railroad fuels." Returns have been received from a large number of oil companies, railroads, and engine manufacturers indicating that a considerable amount of information on this subject is available. If the information secured in the survey indicates that further work is warranted, arrangements will be made for field tests to permit the develop-

ment of field service test techniques capable of predicting results representative of railroad service, and the concurrent development of laboratory techniques capable of evaluating the effects of the factors: lubricating oil, engine design, and operating conditions.

A considerable part of the work of the CLR Vehicle Lubricants Division is concerned with Ordnance problems. The projects include the development of adequate techniques and reference lubricants for evaluating gear lubricants operating under conditions of increasing severity, and the bleeding of greases.

During the past year, efforts have been concentrated on the development of techniques for evaluating gear oils under the more severe conditions imposed by the high powers, weights, and speeds of both commercial and military vehicles.

A report has been prepared covering the development of an improved research technique for the determination of load-carrying, wear, and extreme-pressure characteristics of gear lubricants in axles, under conditions of high-speed low-torque operation, followed by low-speed high-torque operation, which has given results comparable to those obtained in field tests run by the Ordnance Corps at Yuma, Ariz. A new technique for evaluating the scoring tendencies of gear oils is now being developed. The use of a system of reference gear lubricants has permitted the equipment manufacturers to measure the requirements of their axles, and these data, together with actual torque measurements in the gear sets, have provided technical information which should make it possible to develop improved techniques.

At the request of the Ordnance Corps, a study of the bleeding characteristics of greases has been made. In this project, as in the others, data on the correlation of tests with actual field service experience had been lacking. Field data obtained by the Ordnance Corps have confirmed the validity of the proposed test technique, and a report is now being prepared.

The subject of automatic transmission units and their fluids has been expanded to include the study of power-operated accessories, such as power-steering units and their fluids. A tentative technique for studying this problem has been developed, using a commercial automatic transmission. Excellent success has been obtained, indicating the ability to separate poor, borderline, and good oils which have been made available as reference fluids. Additional work is being carried on to develop test apparatus which is not tied to a production transmission unit, and which would thus be more useful as a laboratory tool.

Picking a Truck . . .

. . . to fit the job can save dollars-and-cents in maintenance and operating costs. A simple chart tells power requirements.

Based on paper by **C. T. Kope,** Ford Motor Co.
presented before SAE Southern Calif. Section

BUYING the right truck to carry the payload without undue overloading can save money in worn out parts. By checking a simple chart you can tell if your trucks are underpowered.

The most abused vehicle in the trucking industry is the nominally rated 2-ton truck. The gvw rating offered generally by the industry for this class of vehicle, without the use of optional equipment, is 17,000 lb. Let's see what happens with a gvw of 24,000 lb, since there are numerous operations where this is accepted hauling practice.

Although no specific data are presented here to indicate the probable decrease in engine life because of overload, it may safely be assumed that engine life will be shortened.

In considering the effect of gvw on clutch durability, starting the vehicle from a dead stop is the principal cause of clutch lining wear because of the energy absorbed as heat by the clutch friction surfaces. Clutch manufacturers generally agree that clutch lining life varies inversely as the square of the gross vehicle weight. In other words, the clutch lining life expectancy for the 24,000-lb vehicle is only half that of the 17,000-lb one.

The effect of increase in gvw on transmission life becomes a very significant factor when road load requirements are considered. When accelerating from stop, a longer period of time will be spent in each of the lower gears to arrive at the proper engine up-shift speed. In actual practice, a truck is operated in the lower gears at full engine torque a very small part of its life. Field experience indicates a satisfactory overall durability if dynamometer life in the various gears at full engine torque have the following general relationship:

Gear	Life in hr
First	15
Second	225
Third	2000
Fourth	Infinite

The heavier vehicle will be operated in the lower ratios for longer periods of time and the overall

life expectancy of the transmission will be decreased correspondingly.

Effect on Universal Joint

Propeller shaft universal joint bearing life is affected by increased gvw because of the increase in road torque requirements. The life, in load application cycles, of universal joint bearings varies inversely as the 3.3 power of the bearing load. Doubling the torque will divide the life expectancy by 10 and will, therefore, shorten bearing life by 90%. The increase in torque for road load requirements has a much more significant effect in the lower transmission gears, and since the heavier vehicle will spend a far greater period in the lower gears, the durability of the universal joint bearings will be adversely affected.

Our experience indicates the life expectancy of all truck components to be adversely affected by overload; the individual components being influenced to varying degrees. If overloading decreases the life of components, it obviously increases maintenance expense and operating costs. Conversely, moderate loading probably increases truck revenue and decreases labor costs.

For the trucker with a fixed payload or gvw, overloading results from buying a smaller than recommended chassis, which reduces the investment. Thus, overloading increases some costs and reduces others. The individual operator has to learn by experience what load is most profitable for each truck model in his operation.

An All-Purpose Chart

The relationship between horsepower, gvw, and speed is shown in Fig. 1. This graph is practical and accurate. The accuracy derives from hundreds of test track reports which were studied to determine a constant which ties in the available hp at the wheels with the known hp of the engine. Moreover, numerous vehicle highway speed tests were run in 1954 and the actual speeds approximated the calculated closely, the average variation being about 1 mph.

The graph is based on available hp only and with the assumption of transmission and rear axle ratios being such as to obtain maximum rpm in order to generate maximum hp. Frontal areas of 50 and 75 sq ft were used, the former being the area most commonly used for a straight truck and the latter for a tractor-trailer combination.

A correction of plus or minus 2 mph can be allowed for the 0% grade line depending on the type of truck (straight or tractor-trailer) used. No correction is required on the gradeability lines because at lower speeds the frontal area differential becomes zero, especially at the 2% gradeability line and on up to 6%.

The illustration shows a straight line drawn from a 200 net hp engine to a gross combination weight of 60,000 lb with a resulting 51 mph top speed (2 mph subtracted from the indicated 53 mph).

Conversely the graph can be used to arrive at a required net engine hp when the gross load and desired speed are known or, again, the load can be determined knowing the speed and the engine net hp.

The use of any one factor may not agree in value with the straight forward method of finding gradeability, but the above mentioned combination of values has led to the happy results of boiling down to a very accurate method of determining gradeability. Furthermore, the graph allows a great latitude or flexibility in determination of any one of the three unknown factors indiscriminantly, and without long, tedious calculations.

To Order Paper No. S8 . . .
. . . on which this article is based, turn to page 5.

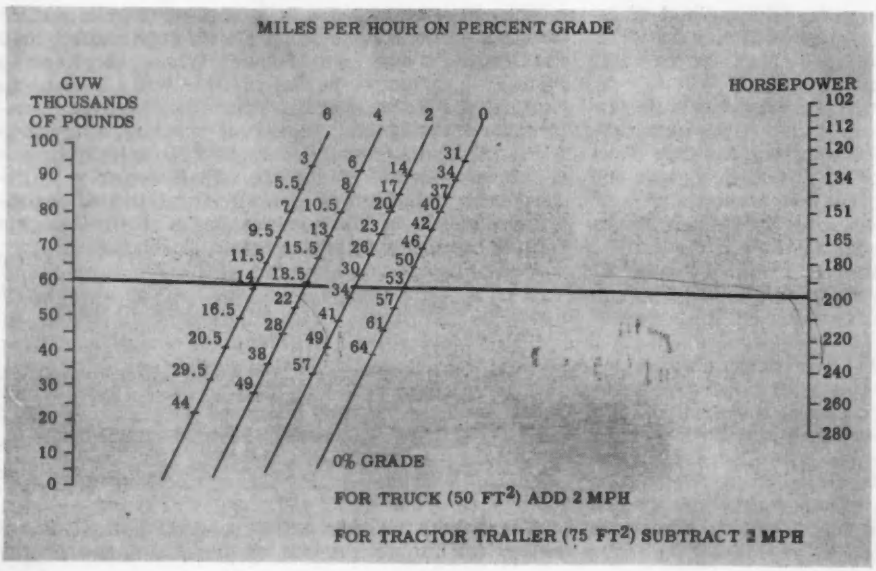


Fig. 1—Use of this simple but accurate chart will give the net power required for a desired load and speed, the speed with a known net horsepower and load, or the gross load with a known net horsepower and desired speed.

European Car Design

. . . How It Evolved and Where It's Heading

Based on paper by

Henry Lowe Brownback,

Régie Nationale des Usines Renault

EUROPEAN motor car design has been influenced greatly by economic conditions, terrain, and the peculiar national characteristics of the consumer. This explains in large degree why the engineer has produced the type of vehicle he has, and why design varies so markedly between countries.

Between World War I and 1934, there were several significant trends. They were: the mass production of closed cars, general adoption of 4-wheel brakes, the hydraulic shock absorber, disc clutch, and independent suspension of front wheels.

There was also a trend toward the lowering of cars which made of the small car a high, dumpy vehicle, unpleasant to the eye. Any attempt to decrease the vertical section of the side rails resulted in weak frames so another solution, conceived in Germany, was to employ a large central tube with fork-like structure in front to carry the powerplant and another at the rear to carry the differential and rear spring mounts, the wheels being mounted on swing axles. The drive shaft ran through the tube, which in turn was located in a tunnel in the body. This construction reduced overall height and unsprung weight and, coupled with balloon tires, revolutionized ideas of motor car suspension.

The next significant trend setter was the revolutionary front-wheel drive car brought out by Andre Citroën in 1933. This car created the present continental European demand for flat floors, removeable complete power units, hydraulic brakes, rubber-mounted powerplants, torsion bar or coiled spring springing, and engines with wet cylinder sleeves in mass production cars. By comparison with it and with other continental rear-engine or front-wheel drive cars, the older formula results in higher floors and tops and a foreshortened line, even when disagreeably high floor tunnels are used.

A few years later Dr. Porsche brought out a rear-engine Mercedes with many of the same power unit characteristics, although it used the classic tubular backbone. It set the style for the small rear-engine, 4-cyl car which leads production in France, Germany, and Italy and dominates the under-1300-cc displacement field. From Germany, too, came the loop-scavenge for the 2-stroke engine, starting a trend toward the use of this type of engine in many small cars.

Just before World War II, Dr. Porsche designed the Volkswagon on the demand of Hitler. It was as revolutionary in the light car field as was the older Citroen in the front-drive field. Since production was launched in 1947 it has become the leading light car in world production. A smaller car of the same general type was brought out by Renault shortly after the war, but it had a 4-cyl water-cooled engine and coil springs instead of torsion bars for springing. The lessons learned from it were used in the design of a larger car to eliminate the bugbear of the rear-engine car—oversteer. This car is the second most widely produced light car on the Continent.

The power unit and driving wheels form one easily removed unit and the body is a welded-steel frameless shell, skin-stressed. The drive and rear brake reaction in the Renault are taken through the power unit so that even the engine and the gearbox housings are stressed, thus eliminating much weight. Skin stressing and the stressing of mechanical unit housings are now distinct trends in continental motor car design. Some parts of this type of design, notably the frameless body, are being adopted cautiously by the British in spite of their innate conservatism.

Right after the war the French also brought out two cars with 2-cyl aircooled engines following aircraft-engine practice. Both cars had front-wheel drives and a frameless body. One was built largely of light metals, but was not as successful as anticipated and steel pressings were substituted. The other car was the first to employ interacting springing in which the movement of one wheel on the end of the car caused a corresponding movement at the other end. This practice has many possibilities and is now being used in a larger car of the same make (Citroen) with interacting hydro-pneumatic sus-

continued on page 65

Aluminum use in cars goes up

Based on Secretary's report by

C. E. Morphew,
Cadillac Motor Car Division, GMC

ALUMINUM continues to make progress as an automotive material—in both decorative and functional applications. But its lack of brightness and relatively higher cost are hurdles which it constantly must jump. Anticipated corrosion problems when aluminum is used with other metals, on the other hand, have not materialized.

Many aspects are involved in aluminum's automotive progress.

Many extruded decorative aluminum sections, for example, do not require polishing. This may be a significant area for cost saving.

The primary limitation of aluminum for interior trim applications, it appears, is that it is not full bright and does not match chrome. Aluminum engineers, however, argue that aluminum is already being freely used in conjunction with stainless on buses. They also indicate many 1958 cars will have aluminum grilles. It is possible the nonmatching arguments of some of the stylists and trim engineers may be losing their validity.

The answer to the question, "Will aluminum replace steel as a decorative material?" is still unanswered. Cost is still the major consideration. Brightness, at least to many automotive stylists, is still very important.

Objections raised earlier to the use of aluminum on car exteriors because it tends to dent easily are now being minimized. Extruded aluminum sections can now be designed to resist denting and experience along this line has been quite favorable.

Ability to tool up fast is a factor favoring aluminum. Also, tooling is often much less costly than for steel trim. These considerations have caught the eye of many cost-conscious automotive engineers.

There is need to develop additional colors for exterior use. At present, gold is the best exterior color in aluminum, but many additional shades are being specified for interior uses. Engineers feel the use of colored aluminum for interiors will be extended appreciably.

By taking full advantage of the latest extrusion techniques, deck lids and even roofs might be made of aluminum. (Such panels might have to have ribs for stiffening.)

The versatility of aluminum as an engineering material seems to be generally acknowledged. This unique property, together with the extensive development work now going on, will undoubtedly extend today's uses of aluminum by the passenger-car industry.

Among interesting possibilities in the future are: new grille applications in the 1958 cars; aluminum bumpers for passenger cars; more use of aluminum in radiators—already well along.

Efforts to produce an all-aluminum car in Europe did not succeed, it was said. All-aluminum frames did not work out; painting problems were encountered; there were also difficulties with spot welding.

About 85% of the automotive use of aluminum today is for functional parts, such as castings and housings. This ratio is not likely to change very much even if significant gains are made in the use of wrought-aluminum products for decorative use.

Round Table, "Aluminum Usage—As Analyzed by the Automotive Engineers," was under the chairmanship of **D. M. Adams** of Cadillac. Panel members were **R. C. Bichan**, Kaiser Aluminum & Chemical Sales, Inc.; **G. M. Haviland**, Fisher Body Division, GMC; **F. H. Mason**, Chrysler Corp.; **A. G. Spear, Jr.**, Ford Motor Co.

6 ways for increasing use of aluminum in today's cars

1. If possible, use one alloy for all cast-aluminum parts.
2. Discontinue, if possible, heat-treatment of permanent-mold castings.
3. Use minimum gage and carry the load through design.
4. Do not substitute aluminum for steel, gage for gage. The aluminum, in most cases, should be heavier unless design is changed.
5. Improve handling in the aluminum permanent mold industry—that is, more automation should be used to hold down costs.
6. Casting tolerances can now be held very close; use these up to their practical limit to save machining.

A New Way to Test For Engine Transient Performance

Based on paper by **Richard N. Shields,** Ford Motor Co.

THE inertia-wheel provides a new tool to measure what happens inside an engine when suddenly called on to accelerate a 4500-lb car from 0 to 60 mph in 10 sec. It is a new way to allow an engine to perform in a laboratory the same way it would in a vehicle on the road.

Inertia-wheel testing represents actual vehicle tests with a fairly high degree of accuracy. Dynamometer tests don't . . . though they are precise, reproducible, and can be well documented.

Inertia-wheel testing can accommodate an almost unlimited amount of instrumentation . . . and produce instrument readings accurate within ±2%. (The nonlineal increase of air resistance is a minor consideration within the 0–60-mph acceleration range.)

Another inertia-wheel advantage is automatic time-based average engine speed.

Suppose, for example, you have a new camshaft which reduces midrange torque and increases high-level horsepower. Will it add to or detract from vehicle performance—assuming a given type of automatic transmission?

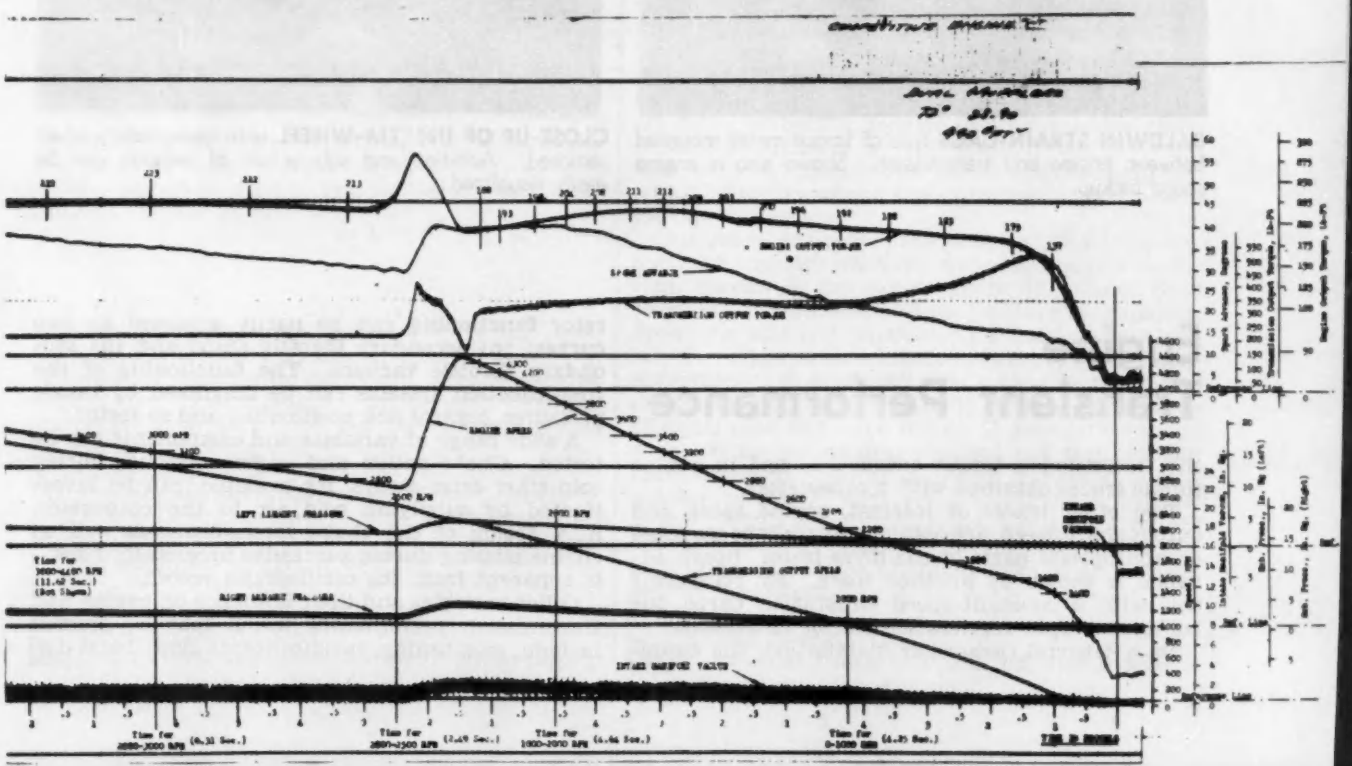
Inertia-wheel testing can give the answer—by operating an engine equipped with the new camshaft through each speed range for the same length of time as in the vehicle. This will average out the gains and losses in a similar manner to a car installation.

The best combination of horsepower and torque characteristics will be the one with the most power at speeds actually used by the engine.

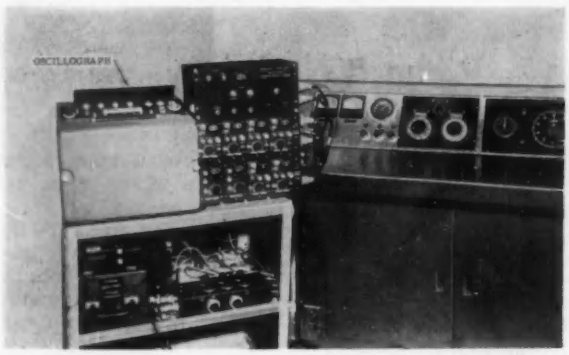
Acceleration times, incidentally, can be corrected for barometric pressure and ambient temperatures by using the reciprocal of dynamometer correction factors.

A sample chart produced by inertia-wheel testing on an engine equipped with a 2-speed transmission is shown below. Roughness, hesitation, missing, rough shifts, and runaway shifts show up clearly in

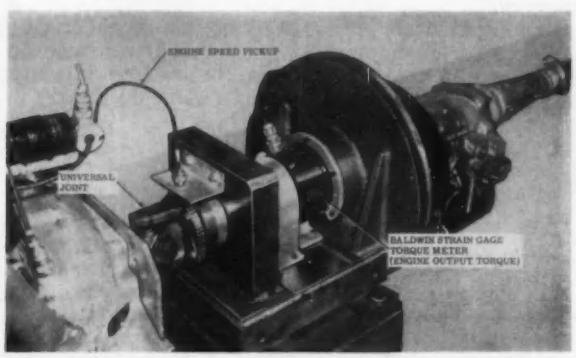
SAMPLE CHART showing results of an inertia-wheel test on an engine equipped with a 2-speed transmission. Chart reads from right to left. Each vertical line represents 1/10th of a second. Horizontal lines are constant speed and zero pressure. By calibration runs, actual numerical values can be read from each curve.



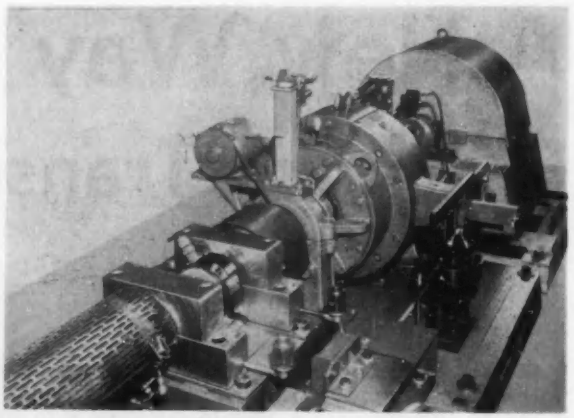
Inertia-Wheel Test Installation



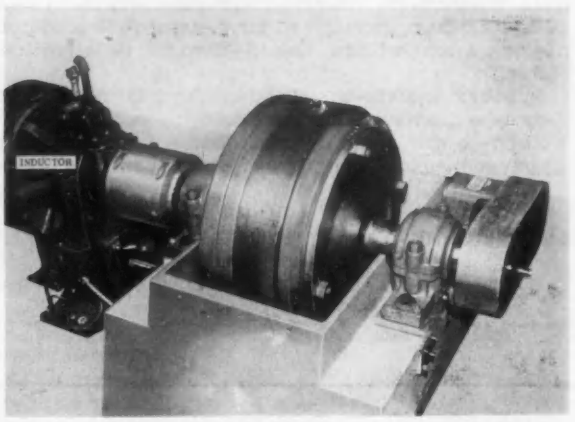
CONSOLIDATED RECORDING OSCILLOGRAPH used to provide a continuous record of engine conditions, in increments of 1/10th sec. To right of oscillograph are amplifiers and power supply.



BALDWIN STRAIN-GAGE type of torque meter mounted between engine and transmission. Shown also is engine speed pickup.



TRANSMISSION TAILSHAFT located with perforated guard. This shaft is connected to a second torquemeter, an inductor, and finally the inertia-wheel. Inductor prevents creep before acceleration run, and slows engine and transmission to idle afterwards.



CLOSE-UP OF INERTIA-WHEEL with heavy safety cover removed. Addition and subtraction of weights can be easily visualized.

Engine Transient Performance

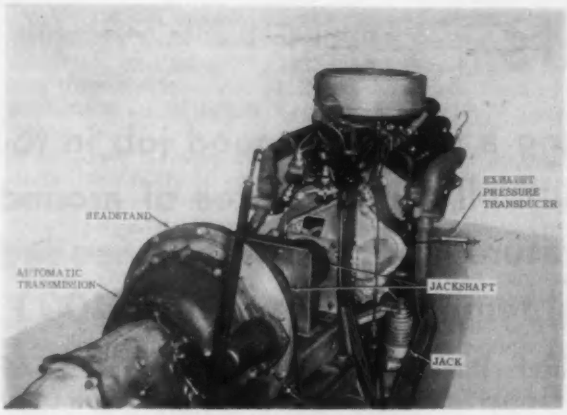
the transmission torque output . . . and in engine torque traces obtained with torquemeters.

Two other traces of interest, engine speed and output shaft speed, are obtained by pickups mounted on appropriate parts of the drive train. Spark advance is shown by another trace. By comparing this with a constant-speed calibration curve, the lag due to rapid acceleration can be determined.

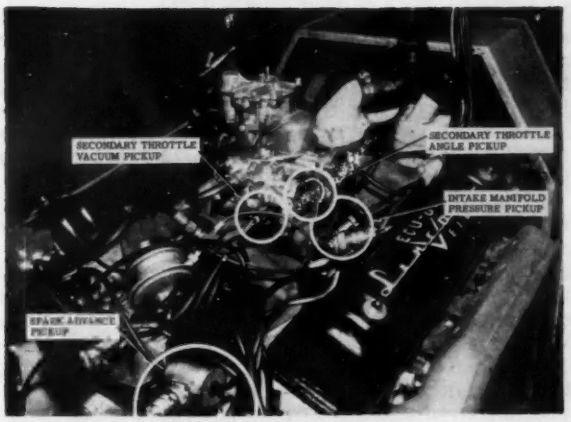
On a 4-barrel carburetor installation, the carburetor functioning can be partly analyzed by two curves: (a) secondary throttle angle and (b) secondary throttle vacuum. The functioning of the fuel-injection systems can be diagnosed by nozzle pressures, control link positioning, and so forth.

A wide range of variables and components can be tested. Choke action and engine response during cold-start drive-aways, for example, can be investigated by supplying cold air to the carburetor. Also, action of the choke mechanism—as well as engine missing during successive accelerator runs—is apparent from the oscillograph record.

Other variables and their influence on engine and transmission performance which may be studied include: cam timing, vacuum versus centrifugal dis-



GENERAL VIEW OF TEST INSTALLATION. Engine, mounted on jacks, is equipped with a complete vehicle exhaust system. Fan and cleaner are also installed. Automatic transmission is shown on vertical mounting surface, with short jackshaft to accommodate a torquemeter between engine and transmission. One of transducers for measuring exhaust system instantaneous back-pressure is visible.



CLOSE-UP OF INSTRUMENTATION. Shown are spark-plug advance pickup; carburetor secondary throttle angle pickup; secondary throttle vacuum pickup; and intake manifold pressure pickup.

tributor, airconditioning compressor, initial spark advance, carburetor jet sizes, distributor types and calibrations, carburetor secondary throttle springs, competitive transmissions, competitive engines, transmission shift points, manifold heat—on and off, exhaust systems, and flywheel mass.

Inertia-wheel testing, in short, is adaptable to: (1) any engine part that changes its position or function with engine speed or (2) developing parts which utilize or deal with heat, air, or gasoline flow . . . and which are subject to time lag.

To Order Paper No. 118 . . .
. . . on which this article is based, turn to page 5.

• European Car Design

How It Evolved and Where It's Heading

continued from page 61

pension. It is revolutionary in motor car springing and may easily set a world trend.

Another almost universal trend in the lighter European car is the use of rack and pinion steering. The above-mentioned Citroen uses pistons on the end of the rack to give power steering.

The resumption of racing by Mercedes-Benz and the adoption of racing practices in its passenger cars has launched a series of trends for larger cars. The first of these is a chassis frame design employing oval tubes in a long X form without side rails. The second is the use of a removeable power unit, steering unit, and front suspension unit mounted on a pressing carried on rubber biscuits to the unit body structure having a single universal-jointed, low-mounted swing axle in the rear. The third contribution is the first highly successful use of direct cylinder fuel injection for passenger-car engines.

Also attributable to Mercedes-Benz are: perfection of the racing-type overhead camshaft engine turning 6000 rpm (the overhead camshaft engine is also used in several successful British cars), tubular space type frame and butterfly doors, radially finned forced draft, self-adjusting brakes (the British have launched what may be a trend toward disc brakes), and, finally, perfection of the light, high-speed diesel engine.

The European sports car or "raceabout" did not die out as it did in the United States. Britain, Germany, and to a lesser extent Italy, continue to build them. They vary from barely disguised racing cars to the "gentleman's sportster" which is usually a fairly comfortable coupe, sedan, or convertible having racing car feel. These sports cars were the vanguard of the mass exportation to the USA. Some have hot-rodded passenger-car engines, while others have extremely modern racing engines made reliable enough for general use. It is significant that with less than 3-liter piston displacement the latest Mercedes direct fuel-injection engine has a 250-hp output.

Our older cars reflect the dream of the engineer; our later ones are what the engineer has had to design, thanks to the tax collector, the Motor Club Technical Committee, and the production engineer. Since the war and particularly since the Suez upset, there has been a distinct swing to the small, economical car and even the cyclecar. With the increasing importance of light weight, every piece of metal used has a job to do. Today, little cars of 30–80 cu in. piston displacement are transporting four persons at highway speeds up to 70 mph in reasonable comfort. They are traversing the highest alpine mountain passes and the African desert and jungle, using very little fuel and oil and having the handling and braking characteristics of their competition ancestors.

To Order Paper No. 126 . . .
. . . on which this article is based, turn to page 5.

Turbine Lubricants . . .

. . . meeting MIL-L-7808 are doing a generally good job in today's aircraft engines despite bulk oil temperatures of around 250 F. But different, high-temperature lubricants will be needed 5-10 years from now when bulk oil temperatures will near 400 F.

Based on paper by **T. F. Davidson and J. H. Way, 1/Lt. USAF**
Powerplant Laboratory, Wright Air Development Center, Air Research & Development Command, USAF

AREAS in which there is need for improvement in MIL–L–7808 oils include corrosion, oxidation, thermal stability, gear and bearing fatigue resistance, and load carrying ability.

MIL–L–7808 oils, when new, are relatively inert to even the most active metals, such as lead and copper. However, upon storage and deterioration these oils become corrosive, particularly to lead. Fortunately, very little corrosion, due to storage instability, has been encountered in service and then only where gas turbines were operated under very specific, and rather abnormal, conditions. However, improvement is desired. The mechanism of deterioration and means for improving storage stability are presently being studied. Such factors as temperature, oxygen and water availability, and impurities appear to be important variables in storage stability.

Even though MIL–L–7808 oils are a vast improvement as regards thermal and oxidation stability over light mineral oils, with prolonged operation (several hundreds of hours) at 250 F bulk temperatures, quite heavy sludge and coke buildup can occur. The same condition arises in shorter periods of time when operation is at higher bulk temperatures. MIL–L–7808 oils consist of a diester base stock (sebacate, azealate, or adipate) with additives to impart desired viscosity, oxidation-corrosion, and load-carrying properties. A great deal of effort has been expended in trying to gain improved oxidation and thermal stability through addition or elimination of additives. Certain viscosity improvers have been found to be very effective sludge dispersants and will, it appears, very greatly improve the "sludging" problem.

Thermal stability on the other hand, we believe, is primarily a base stock function. If oxidation is properly inhibited, it cannot be improved by additives. This finding has been borne out in some 3000 hr of engine testing on our part.

Bearing and gear fatigue are beginning to be a problem. With bearings, apparently fatigue resistance is primarily influenced by lubricant viscosity. With gears, load-carrying ability seems to be the key lubricant property.

Although the load-carrying ability of MIL–L–7808 oils was adequate for early turboprop engines, with some existing engines about the best that can be said is that load-carrying ability is marginal. This means, of course, that future turboprop engines will require oils of higher load-carrying ability than MIL–L–7808 oils. It is hoped that MIL–L–25336 oils will be found suitable for these applications. (MIL–L–25336 oils are identical to MIL–L–7808 except possessing a 2800 ppi minimum Ryder rating as compared to 1700 ppi minimum for MIL–L–7808.)

At Mach 2.3 the ram air rise is in the neighborhood of 400 F, which is approximately the bulk oil temperature level at which future engines will be operating. Therefore, it is obvious that in the future ram air oil coolers will be impractical during high speed operation because they could conceivably act as oil heaters rather than coolers. This one factor alone is responsible for considerable revision in thinking as to how the lubricant will be used.

In present engines, the oil serves two functions: It lubricates, and it acts as a coolant. In the "divided" lubrication system—which may be the lubrication system of the future—lubricant and cooling functions are basically divorced. Hence the designation "divided" system. Oil for lubrication is supplied to the bearing. But cooling may be accomplished by (1) injection of a volatilizing coolant, taking advantage of the heat of evaporation, or (2) circulation of coolant around the bearing compartment. The circulating coolant could be either oil, fuel, or some other heat transfer medium.

At this time, esters and mineral oils appear to be the most promising high temperature candidates for the future. However, the silanes and silicones also have very interesting properties and if their current defects could be corrected then they too, would be prime high temperature candidates.

At the present, diester, fluoresters, and pentaerythritol esters are the most promising esters. Esters, like mineral oils and other promising high-temperature lubricants, have relatively poor low temperature properties as compared to MIL–L–7808 oils. It appears that the price of high temperature lubricant performance may well have to be a compromise of low temperature lubricant performance. Some investigators believe that a relaxation of 1 F at low temperatures (–65 F) may be reflected in a 2–3 F gain in high temperature (bulk oil) performance. Very limited engine data appear to substantiate this rule of thumb with the materials so far investigated.

With mineral oils it is hoped that certain new de-

velopments in mineral oil processing such as solvent extraction techniques, vacuum distillation, hydrogenation, and improved additives—all presently being investigated—will yield even further improved materials, including better low-temperature properties.

Silicones have exhibited one very alarming tendency: Normally a given size anti-friction bearing when operated at a specific speed and lubricant flow and with a lubricant of known viscosity will stabilize at some predictable temperature. Such a relationship has been found true of both mineral and ester lubricants. However, much higher than predicted bearing stabilization temperatures have been encountered with silicones. The reason for such unpredictable bearing stabilization temperatures is unknown at this time but is under investigation by a number of organizations.

Another drawback of silicones is their poor wear resistance, with both steel and carbon. The possibility of correcting this deficiency appears remote at this time. Until the above weak points are remedied silicones appear out of the picture as gas turbine lubricants.

Based on laboratory studies, silanes appear to possess thermal stability comparable to silicones. Unfortunately, very little mechanical evaluation of silanes has taken place to date, and the results have varied with the type silane evaluated. Aromatic silanes appear poor in wear resistance, whereas alkyl and aryl silanes have wear properties comparable to non-inhibited diesters. Larger quantities of several silanes are currently being prepared for extensive mechanical evaluation.

Based on Discussion

Robert W. Schrum, Sinclair Research Laboratories, Inc.

ONE of the most important requirements of future lubricants is, obviously, improved thermal stability or, alternately, a fluid whose decomposition products are harmless or, ideally, a combination of both. Thermal stability is a function of molecular structure. Some or all of the accepted 7808 diester fluids contain relatively unstable hydrogen on the beta carbon of the alkyl groups which is involved in thermal decomposition, yielding olefinic linkages and acids. Therefore, the diesters can be thermally improved by substituting more stable groups for the B-hydrogen.

With regard to increased gear-load-carrying ability, conventional additives proved unsatisfactory because of undesirable side effects. However, an entirely new concept in extreme pressure additives has led to the development of a family of additives which enhance the ability of even 3.0 centistoke fluids to carry, not 2000 lb per in. of tooth width in the Erdco Universal Tester, but 4500–5600 lb or more per in. Incidentally, these additives also protect the gears in the gear cases of aircraft gas turbines, with regard to both load and fatigue.

Bearing fatigue appears to be a function of viscosity—the higher the viscosity the greater the reduction of bearing fatigue. The use of additives to reduce bearing fatigue has not, however, been excluded and is under investigation.

Another very important characteristic of turbine engine lubricants needing improvement is corrosion and oxidation resistance. Again the preparation of new additives appears the most promising route, although the possibility of excluding prolonged high temperature contact of air and lubricant should not be overlooked as an expedient solution.

We all are grateful to the people at WADC for their aid in helping us solve the past problems, and we look forward to their continued cooperation and guidance in meeting the new challenges.

* * *

R. E. Barnum, Esso Research and Engineering Co.

ARE sufficient data available to indicate what level of viscosity is required to protect against bearing fatigue?

Does the Hyatt Index correlate with field performance?

WADC data on high-temperature synthetic oils show the pentaerythritol esters to have considerable potential for meeting MIL-L-9236 specifications. However, current specifications rule out materials of the pentaerythritol ester class on the basis of viscosity change and neutralization number change after 500 F oxidation-corrosion. If specification revisions were to be made, this might conceivably open the door to many new high-temperature synthetic oils. We would appreciate hearing from the authors how firm the current 9236 specifications are on allowable viscosity and neutralization number change.

In carrying out the 500 F oxidation-corrosion test, we have found that on a number of occasions the cord used to join the metal specimens together actually disintegrated at the 500 F temperature level, and the specimens collapsed into a pile leaving a minimum of exposed surface. Test results in such a situation are obviously of questionable significance. We bring this point up mainly to inform those who may be planning to carry out come 500 F oxidation-corrosion tests for the first time.

T. F. Davidson's Reply

UNLESS adequate gear metals can be developed, oils having 15 centistokes viscosity will be required for satisfactory gear lubrication at 400 F.

A reasonably good correlation exists between laboratory and field experience with regard to bearing fatigue when using MIL-L-7808 and "heavy oil."

In connection with oils for operation at elevated temperatures, target specification MIL-L-9236 has recently been revised. Those having promising products should submit them to WADC for evaluation even though the oils do not meet all the requirements of the specification. WADC desires to write a procurement specification for such oils by the end of the year.

* * *

E. A. Ryder, Consultant

THE data in the literature on the effects of lubricant viscosity on ball bearing and gear fatigue are not consistent. Some of the data are contradictory and effects attributed to viscosity may, in some cases, have been due to other factors. Work reported in England has indicated that in fatigue tests on single balls viscosity effects were not so important as might have been expected.

* * *

To Order Paper No. 98 . . .
. . . on which this article is based, turn to page 5.

Engine rpm and cruise speed are Prime Factors Affecting

Table 1—Relation of Average Speed to Cruise Speed and Relative Economy

Cruise Speed	Average Speed	Average as % of Cruise	Mpg at Cruise
30	27.8	93	8.2
35	31.4	90	8.0
40	34.8	87	7.66
45	37.8	84	7.25
50	40.2	80	6.80

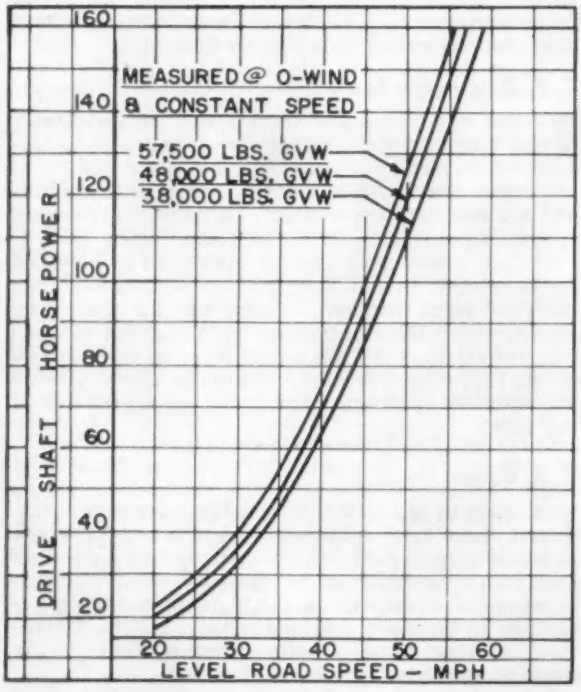


Fig. 1—Speed has much more influence on economy than weight, hence speed control is the path to decreased fuel consumption.

Based on paper by

J. C. Miller,

Cummins Engine Co., Inc.

A SERIES of tests under actual operating conditions show that fuel economy of a dieselized commercial vehicle is affected by various factors in the manner following:

1. Cruise speed is a prime factor in fuel consumption.

2. Average speed does not increase in proportion to cruise speed.

3. Total engine rpm is a prime factor in fuel consumption. High engine speed, gear shifting for heavy traffic, and hill climbing all give a high total rpm and low mpg.

4. At a given road speed, fuel burned increases as the engine speed, and total rpm are increased. Fuel is wasted in pumping air. Rear-axle ratio affects this somewhat, but the greatest loss comes from driving in a gear lower than that required to maintain position in traffic.

5. At maximum engine speed, fuel economy is low regardless of road speed.

6. Best mpg economy is obtained at the lowest engine speed at which position in traffic can be maintained.

Diesel Fuel Economy

7. Higher engine horsepower increases performance (hill climbing and acceleration) and cruise speed, and decreases gear shifting and economy (mpg). Average speed may or may not be increased, depending on traffic and driver schedule.

8. Under some conditions, higher horsepower may require less gear shifting and give better fuel economy, if the total engine rpm should be reduced.

For purposes of this investigation, tests were run with (1) a Kenworth tractor model TCF-521 with Cummins JT-6 engine and Fruehauf trailer model VVAR-5535-FF-SP. (2) a conventional tractor with a naturally aspirated engine of competitive make and approximately the same power. (3) the conventional tractor with a Cummins JT-6 installed for direct comparison of the two engines. The tractors were extensively instrumented and driven by an experienced truck driver, not an engineer.

Weight affects economy, but speed affects it far more, as shown in Fig. 1. At 40 mph, an increase from 38,000 to 48,000 lb in gross vehicle weight required an increase from 64 to 70 in shaft horsepower. But increasing the speed of this same 38,000-lb vehicle from 40 to 50 mph required an increase in shaft horsepower from 64 to 111. In other words, a 25% increase in speed required a 73% increase in power, while a 26% increase in weight only required a 10% increase in power.

A distinction must be made between average speed and cruise speed when considering the effects of speed on economy. Average speed is the distance traveled divided by the time required, whereas cruise speed is the road speed required to achieve the average speed. Average speed does not rise proportionately with the rise in cruise speed.

Table 1 shows the relation of average speed to cruise speed and the relative economy with the 48,000-lb gvw tractor-trailer rig. As a rule of thumb, in this speed range, each mph increase in cruise speed drops the economy by roughly 1/10 mpg, and each mph increase in average speed lowers the economy by roughly 1/7 mpg.

To drive the rig at increasingly higher speeds re-

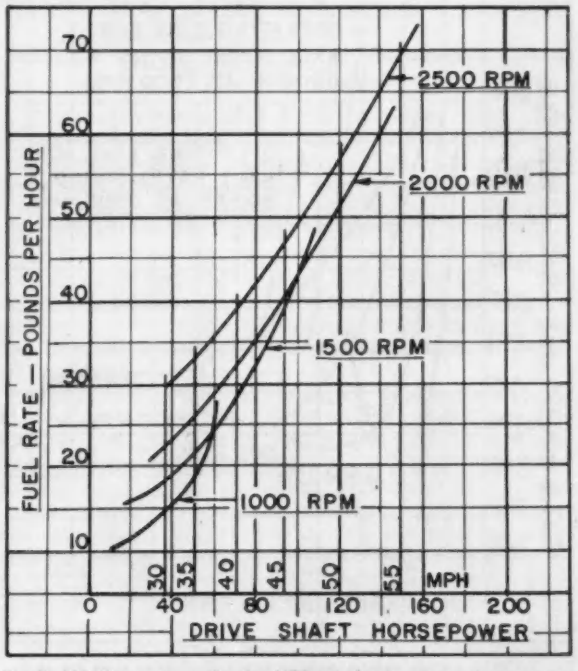


Fig. 2—Winding up an engine by shifting to lower gear, a common practice to get better acceleration, is one way of wasting fuel. (Tests made with 48,000-lb gvw vehicle.)

quires a rapidly increasing drive shaft horsepower. With reference to Table 1, it can be seen that an increase in cruise speed from 35 to 50 mph only gave an increase in average speed of 8.8 mph. But Fig. 1 shows that to cruise at 50 mph with 48,000-lb gvw required 120 shaft horsepower, rather than the 50 hp required at 35 mph, or 140% more. This is only shaft horsepower. The engine horsepower and fuel burned would be even more because the engine, fan, transmission, and accessory losses would add up, too, for the higher speed.

The fuel used in pounds per hour for increasing speed is shown in Fig. 2. At 35 mph, with the engine turning 1500 rpm, 21.5 lb of fuel would be required. At 50 mph, with engine turning 2000 rpm, 51 lb of fuel per hr would be required. For a 28% increase in average speed, 137% more fuel was used.

The foregoing assumes good driving practice in keeping engine speeds low. Fig. 2 shows that the 50 hp required at 35 mph would be obtained at 1500 rpm or higher. But if the engine were wound up to 2500 rpm by the common practice of shifting to a lower gear, 33 lb of fuel per hr would be needed, or an increase in consumption of 53%. At 50 mph an increase in rpm from 2000 to 2500 would increase fuel consumption from 51 to 57 lb of fuel per hr, an increase of 12%. It is almost always possible to drop down a gear for an improvement in acceleration, but the engine speed becomes higher than desirable for best economy.

Effect of Final Drive Ratio on Economy

There is usually an optimum combination of engine horsepower, transmission, and rear-axle ratio which will produce the best fuel mileage for any set of operating conditions. Fig. 3 illustrates this point.

The solid lines are bsfc in lb/bhp/hr plotted against brake horsepower output of the engine for various engine rpm's. The two dash lines are road load engine horsepower requirements in high gear determined by road tests. The upper dash curve for a rear-axle ratio giving 45 mph at 2500 engine rpm shows that at 45 mph the engine power is approximately 110 hp and the specific fuel consumption is approximately 0.45 lb/bhp/hr. The lower dash curve is for a rear axle giving 50 mph (instead of 45) at 2500 rpm, and the same 110 hp needed to drive the vehicle is obtained with a specific fuel consumption of approximately 0.422 lb/bhp/hr. This is about 7% lower.

The foregoing illustrates that with a given cruising speed the final drive ratio has an important

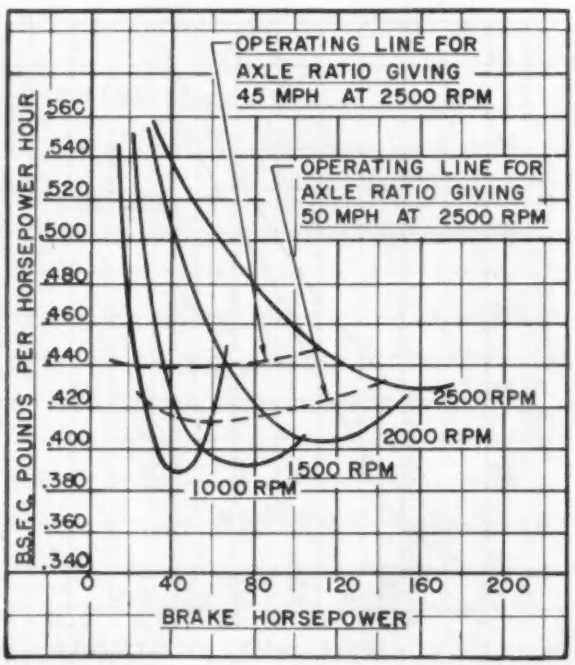


Fig. 3—With a given vehicle cruising speed, final drive ratio has an important bearing on built-in, over-the-road economy. (Engine dynamometer test.)

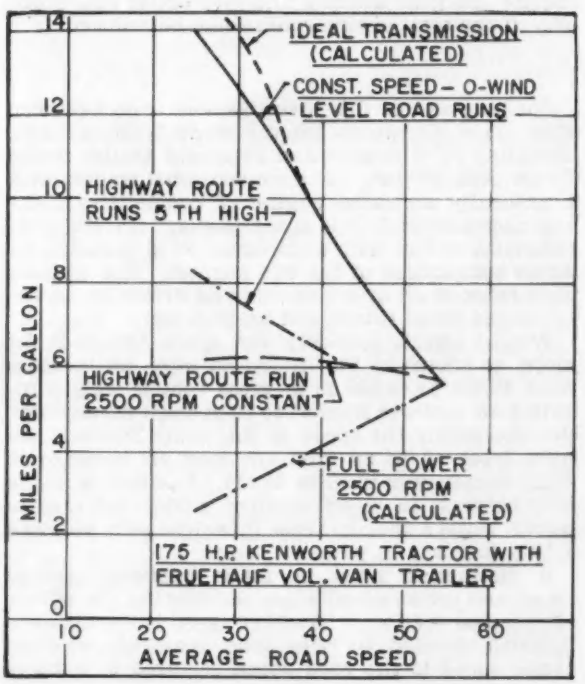


Fig. 4—Only by good driving practice can built-in, potential economy of a vehicle be approached.

bearing on the built-in, over-the-road economy. A comparable gain in the efficiency of today's highly developed engines is difficult to achieve.

The "Why" of Engine Speed

In passenger cars, the improved economy obtained with an overdrive which reduces engine speed has been recognized, but the reason has not been too clear. The "why" is shown in Fig. 3, which presents a typical plot of engine fuel consumption at different speeds. Each curve has a minimum point. At powers less than this, fuel beyond that needed for power is burned just to pump air and run accessories. At power greater than at the minimum point, combustion efficiency falls off, more fuel per horsepower is used until a point is reached where there is not enough air to burn all the fuel and smoke increases rapidly.

The ideal condition for best economy would be to turn at the lowest point of the fishhook curves. This is not always possible, but it can be approached very closely in practical operation by running in the highest gear with which position in traffic can be maintained. Actual road tests confirm this for all conditions of load and speed, as shown in Fig. 4.

The top dash calculated curve represents the mpg to be expected at various road speeds with an "ideal" transmission to operate the engine at a speed always producing the required horsepower at the lowest specific fuel consumption. The solid curve adjacent is for actual test data in fifth high gear and shows the "ideal" transmission contributing no great improvement for these conditions.

To determine the potential built-in economy, runs were made simulating level road, zero wind operation, with fixed throttle settings to eliminate the effect of driver and traffic. The solid diagonal line shows the economy under these ideal conditions. At 35-mph average speed, 11.2 mpg were obtained with 57,500-lb gvw and the 4.75 axle. This is the built-in potential which practical considerations prevent attaining in normal operation, although there are instances of trucks in commercial runs getting better than 10 mpg.

The bottom dash-dot-dot curve was calculated on the basis that the truck is geared and operated under conditions requiring continuous use of full engine power at rated engine speed. This is the lowest possible fuel mileage at the various engine speeds.

The horizontal line shows the mpg obtained when runs were made with the engine wound up to about 2500 rpm at all times by selecting the transmission gear to keep it so. This is common practice with some drivers who want the better acceleration. Regardless of the average speed, only about 6 mpg were obtained, which shows the small importance of wind and rolling resistance relative to poor driving practice under these conditions.

The dash-dot line shows the mpg obtained when runs were made with the practice of using the highest transmission ratio possible with maintenance of position in traffic. At 35-mph average speed, 7 mpg was obtained with 57,500-lb gvw and 4.75 axle. From these tests and curves it is apparent that at 35 mph, about 11.2 mpg is built into the rig, but only 6.15 mpg, or 55% of this potential is realized when the engine is wound up to 2500 rpm. On the other hand, with good practice, 62.5% or 7 mpg can be had.

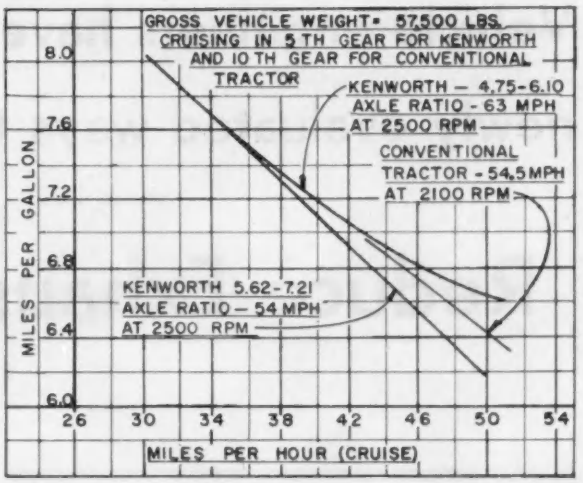


Fig. 5—Comparative fuel mileage of conventional tractor and Kenworth tractor. The rule holds that with each mile per hour increase in cruise speed economy drops 1/10 mpg.

Effect of Terrain

Tests with engines of different power show that optimum power is determined by the schedule and the terrain. Higher horsepower does not necessarily give higher maximum speed, because of axle ratio or legal limit, but does give better acceleration and less shifting on grades, which reduces trip time. Under some conditions, fewer rpm resulting from less shifting could give even better economy. The need for performance given by increased horsepower must be weighed against economy desired and the best compromise selected for the particular operation and operator.

Fig. 5 shows the comparative fuel mileage obtained with the conventional tractor and Kenworth tractor. Above 36-mph cruise speed, the Kenworth fuel mileage was improved with the 4.75 ratio axle, giving an increase of about 0.47 mpg at 50-mph cruise speed. Below 36-mph cruise speed, there is no significant difference in fuel mileage between the tractors, or between the two gear ratios tested in the Kenworth. With both tractors on these runs the rule of thumb holds that with each mph increase in cruise speed the economy drops by roughly 1/10 mpg. For good economy, both engine revolutions per mile and cruise speed must be limited.

To Order Paper No. 142 . . .
. . . on which this article is based, turn to page 5.

Vehicle engineers have newly evaluated ways to

Reduce Exhaust Hydrocarbons

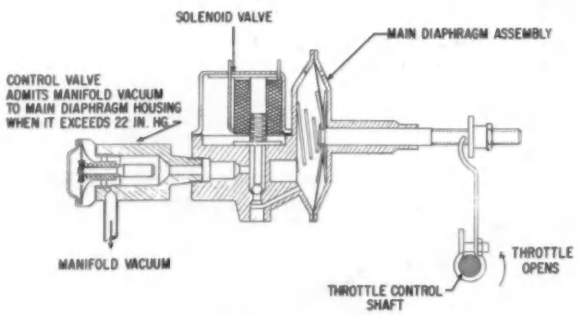


Fig. 1—Vacuum control throttle opener.

THE principle of the vacuum-limiting type of device appears to have better suitability for universal application than do other approaches to controlling hydrocarbons during motor vehicle deceleration.

This is the opinion of the Automotive Manufacturers Association's Induction System Task Group, following two years of building, testing, and evaluating devices to reduce unburned hydrocarbon emission. The Group emphasizes, however, that "it is questionable that any single device is entirely suitable for universal application."

In addition to the vacuum-limiting devices, the Group has tested:

- A slow throttle return dashpot;
- Several types of idle fuel shut-off devices;
- A device for interrupting ignition during deceleration; and
- A number of miscellaneous devices also aimed at control of hydrocarbons during deceleration.

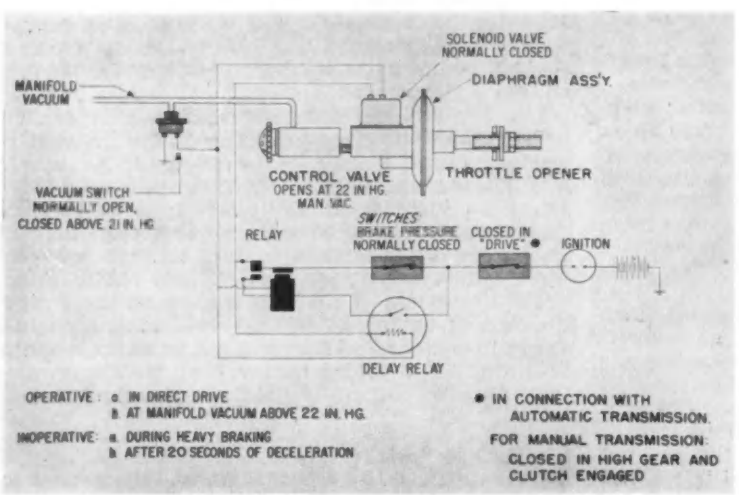


Fig. 2—Control circuit diagram for vacuum control throttle opener.

Based on paper by

Induction System Task Group,*

Automobile Manufacturers Association

During Deceleration

The vacuum-control throttle opener was one of two carburetor throttle-control devices tested. The unit tested is shown in Fig. 1. This device automatically opens the throttle when necessary and desirable to reduce and regulate manifold vacuum to a predetermined value. The device consists of:

1. A vacuum-operated throttle opener which acts against a lever on the throttle shaft; and

2. A pilot control valve to evacuate the throttle opener as required to get any necessary reduction in manifold vacuum to maintain the desired limit.

In operation, manifold vacuum acts on the control valve diaphragm. When this vacuum exceeds the value needed to overcome the control valve spring, the control valve opens and vacuum is allowed to act on the main diaphragm. This controls the throttle opening through the throttle control shaft lever. Thus manifold vacuum is reduced to the desired limit as determined by the control valve setting.

The electric solenoid valve makes the device inoperative except when its action is desired (basically, decelerating in direct drive).

On automatic transmission cars, a pressure switch can be located in the transmission hydraulic line associated with direct drive, or on the shift linkage. On manual transmission cars, switch interlocks prevent operation except when the clutch is engaged and the transmission is in direct drive. These controls prevent engine "idling" at high speed at the

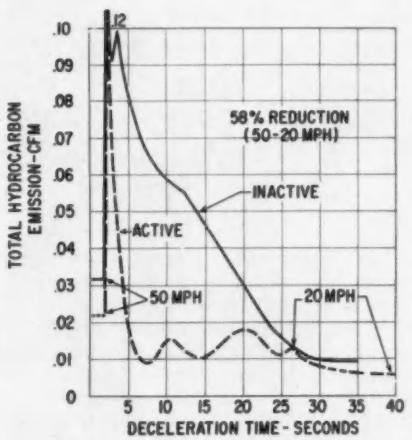


Fig. 3—Exhaust hydrocarbon emission during deceleration from 50 mph using vacuum control throttle opener.

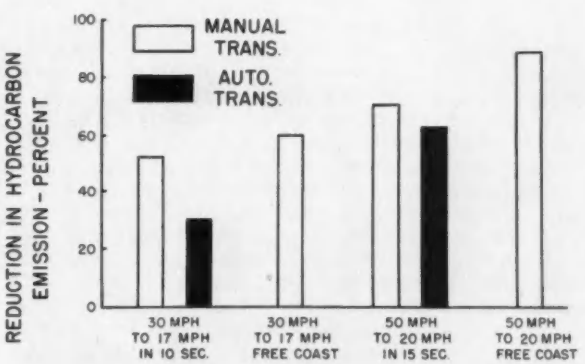


Fig. 4—Unburned hydrocarbon reduction using vacuum control throttle opener with manual and automatic transmission cars.

* The Induction System Task Group consists of **H. H. Dietrich**, Rochester Products Division, GMC, chairman; **C. E. Burke**, American Motors; **R. E. Clark**, Chrysler; **N. R. McManus**, Ford; **W. J. Pelizzoni**, Mack Trucks; **R. D. Randall**, Stewart-Warner; **A. Rudolph**, Ford; **J. L. Smith**, Studebaker-Packard; **J. T. Wentworth**, GMC; **E. P. Wise**, Chrysler.

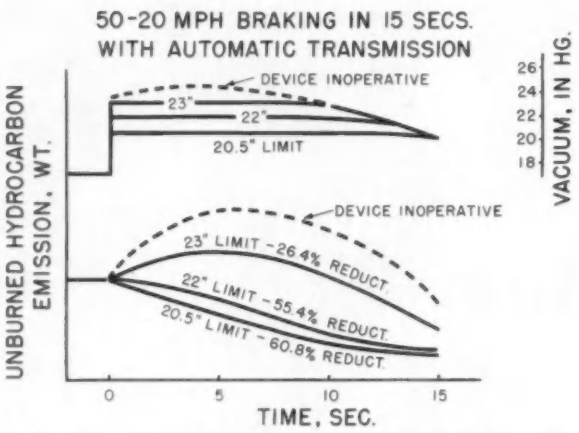


Fig. 5—Results of tests to determine best vacuum limit for vacuum control throttle opener.

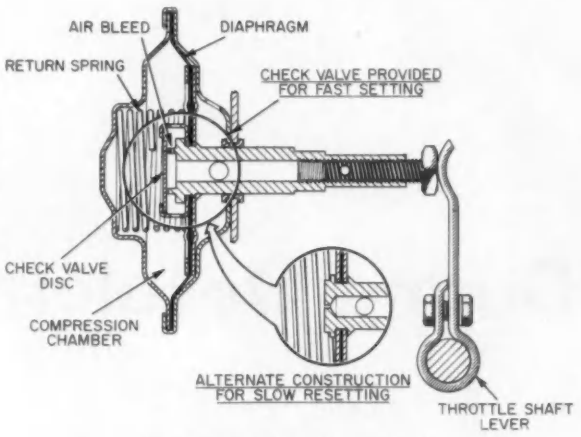


Fig. 6—Slow throttle return dashpot.

control vacuum when in neutral, and they permit full engine braking in the lower gears. The device is also inoperative when maneuvering at low speed, such as parking.

Since the basic control will have an adverse effect on engine braking in high gear, and since this is not a temporary condition as it is with a dashpot, means should be provided to limit the time that the device will operate without "resetting." One such method is shown in Fig. 2. Also shown is a means of making the device inoperative during heavy braking through the use of a brake line pressure switch.

Fig. 3 shows a sample measurement of unburned hydrocarbon emission during deceleration with and without a vacuum-control throttle opener.

Typical reductions in unburned hydrocarbons are shown by Fig. 4 for manual and automatic transmission cars. It is seen that the reductions are appreciable for all deceleration conditions. The biggest gain is, of course, obtained with the manual transmission cars because the unaltered deceleration vacuums are highest with these cars.

A preliminary survey to determine the best vacuum limit value was run and results are shown in Fig. 5. Though about 20.5 in. Hg produces the best results under the conditions tested, no great loss is incurred in raising the vacuum limit to 22.0 in. Hg and the car driveability is considerably improved.

During a traffic run the *overall* level of hydrocarbon emission from cars with and without the vacuum-control throttle opener was determined. Results indicated 25% *overall* reduction with manifold vacuum set at 22 in. Again much additional data are needed to firmly establish such a figure.

To determine what effect the throttle opener has on economy, both deceleration economy and traffic economy tests were run, using automatic transmission cars. Test results indicate that although a 21% increase in fuel consumed was noted in deceleration from 60 to 10 mph in gear (44.7 versus 54.3 mpg during deceleration, device on and off), the amount of additional fuel used per mile of deceleration was only about 0.004 gal.

The loss in engine braking during deceleration with the vacuum-control throttle opener is serious. A decrease of 24 and 31% in engine braking at 40 and 50 mph respectively was measured on one car with the device opertaing at 21 in. Hg, and though a setting of 22 in. Hg helps reduce this loss, the effect on braking lining wear is significant. From a safety standpoint, it is necessary to add a brake hydraulic pressure switch to cut out the device when severe braking is required. Without such a cutout, ability to make repeated high speed stops was reduced 25% on one car tested. To make direct gear engine braking available when descending long, moderate grades (second gear not required), a time delay circuit is necessary to prevent operation of the throttle opener for longer than is necessary for traffic-type decelerations (up to about 20 sec).

With the vacuum-control throttle opener set to control at 22 in. Hg and operating in direct drive only for a maximum of 20 sec at a time, driveability is not affected to a noticeable degree. The car has a feeling equivalent to "free wheeling" in normal traffic non-braking decelerations, and there is always a more than normal need for brake application. This effect is no more pronounced, however, than is experienced in the transition from manual to automatic transmission cars, and it is expected that most drivers would become accustomed to it.

Experience with the vacuum-control throttle opener has shown the following:

1. Reduction in unburned hydrocarbon emission is good under all deceleration conditions. Overall

effectiveness is better than with any other practical device tested.

2. Installation is not difficult either in production or in the field. However, the number of controls required makes installation time considerably greater than the simple dashpot.

3. Cost of the package is within an acceptable range and no extensive tooling is required.

4. Driveability is affected by the requirement for increased brake use.

5. Brake wear in traffic driving is substantially increased, but the amount involved is not yet known. This is a major objection to the adoption of this device.

6. Fuel economy is affected to a negligible extent.

7. The vacuum throttle opener can probably be depended on to maintain accurate control of unburned hydrocarbon emission. Functional inspection can be reliable. Inactivation by the owner is relatively simple, however, and policing methods will have to be developed.

Slow Throttle Return Dashpot

Fig. 6 shows the principle of operation of the slow throttle return dashpot. It is seen that as the throttle reaches a point near closed position, a lever on the throttle shaft engages the dashpot plunger. Air or liquid is trapped behind the diaphragm of the dashpot, slowing the throttle closing. The rate of closing from this point is determined by the rate of bleedout of the trapped fluid. Return of the dashpot plunger after the throttle is opened is accomplished by an internal spring. The return action (resetting) can be speeded up by a check valve which opens into the compression chamber during the return stroke, or it can be made slow through use of a simple orifice into the chamber.

The reason for installing a carburetor throttle control of course is to prevent high manifold vacuum. Since the dashpot is a pre-set, non-feed back type of device, it cannot accurately control throttle position to obtain optimum manifold vacuum under all decelerating conditions, but must be tailored to be most effective for the conditions most frequently encountered.

As a result of increased engine power developed during deceleration of a dashpot equipped car, decreased engine braking is obtained. This adversely affects driveability, so it is desirable to limit the dashpot bleed-down time to a minimum, while maintaining good effectiveness. Since most traffic decelerations last less than 10 sec, it is generally considered unnecessary to exceed this figure in bleed-down time. It appears likely that 6 sec may give acceptable results, though additional testing is desirable to establish this.

If the dashpot is of the fast-reset type, it is always ready to catch the throttle return stroke, even if the throttle has been open only a short time. This causes a serious driveability difficulty when maneuvering the car for parking or when driving in slow traffic. Consequently, a slow reset type dashpot is considered preferable, or even necessary. Some loss in effectiveness occurs since the dashpot controls a smaller portion of the time, but the gain in driver control is very much improved.

The effectiveness of the slow throttle return dashpot in reducing unburned hydrocarbon emission cannot be represented by a single series of tests. Too many variables are involved. However, the fol-

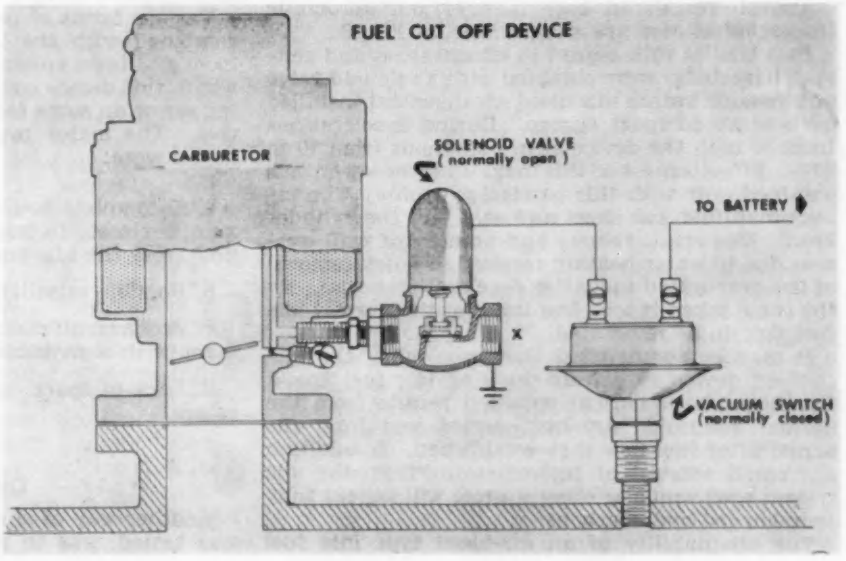


Fig. 7—Fuel cutoff device.

lowing summary of many tests of different cars is presented:

Short decelerations from 35 mph or less:

	Hydrocarbon Reduction, %		
Car Type	Min	Max	Average
Automatic Transmission	12	66	46
Manual Transmission	46	75	61

The effectiveness of the device on manual transmission cars is much greater than on automatic transmission cars simply because the car "motors" the engine during deceleration more efficiently through the solid coupling provided by the manual transmission, and, therefore, a greater intake manifold vacuum is created. The result is poorer combustion for the manual transmission car without a device, providing more opportunity for improvement. One type of automatic transmission car emits roughly one-third of the hydrocarbons that its manual transmission counterpart does under typical traffic deceleration conditions (no device).

Idle Fuel Shut-Off Devices

Also tested were several typical devices designed to shut off idle fuel-flow during deceleration.

Several of these were air-bleed types which admit air into the idle system under high vacuum conditions, thus cancelling the suction head that normally causes the fuel to flow through the idle system.

Fig. 7 shows an idle fuel shut-off air-bleed device consisting of a solenoid valve and a vacuum switch. This arrangement has the advantage of further reducing hysteresis with resulting improved effectiveness and recovery characteristics.

Typical exhaust hydrocarbon emission curves were obtained during a free deceleration from 50 mph, with an air-bleed type device first active and then inactive. In one case, a 66% reduction in hydrocarbon emission was obtained, which is a typical value for numerous test runs with various manual transmission cars.

Typical results on both manual and automatic transmission cars are summarized in Fig. 8.

Best results with regard to effectiveness and general driveability were obtained with a solenoid valve and vacuum switch idle bleed arrangement installed on a small compact engine. During decelerations from 50 mph the device gave reductions from 70 to 90%. Effectiveness of this magnitude, however, was obtained only with this particular engine. The intake manifold was short and cast into the cylinder head. The small volume and absence of wall wetness due to water heating resulted in quick removal of the evaporated fuel after deceleration began. By the same token it took less time for the normal idle fuel flow to be reinstated.

It may be summarized that even when the idle shut-off device effectively shuts off idle fuel flow a significant hydrocarbon emission results from the normal manifold "dry out" period and from the period after fuel flow is re-established. In addition any small amount of fuel emerging from the idle system bowl vents, or other sources will appear fully as unburned hydrocarbons.

The adaptability of an air-bleed type idle fuel shut-off to old carburetors appears difficult unless the device can be sandwiched between the carburetor and intake manifold, or between the carburetor throttle body and main body. This will normally increase carburetor height, which usually is at a premium. Furthermore, most existing carburetor idle systems are generally inaccessible and seldom permit a simple connection to a device. Most carburetors used today would require use of multiple devices with long connecting air bleed passages to permit interference with air cleaner and other engine components.

The installation of an air-bleed type device, in many cases, could be made more conveniently on some new design carburetors where a fitting and passage could be provided leading directly to the idle system. In other cases it may be possible to build the device integral with the carburetor body. Extreme difficulties arise in connection with new design, low-built multi-barrel carburetors, especially when they incorporate four separate idle systems.

Positive Idle Fuel Shut-off

Tested also were devices in which a valve mechanically shuts off the idle fuel-flow during deceleration.

A valve which mechanically shuts off the idle fuel flow during deceleration should, if properly constructed, leave no doubt about a complete stoppage of idle fuel flow. Fig. 9 illustrates such an installation on a four-barrel carburetor with two separate idle systems. Two valves were operated simultaneously by one solenoid, energized by a vacuum switch. A 60% reduction in hydrocarbon emission was obtained during deceleration from 50 to 20 mph. In spite of the apparent complete fuel shut-off, there remains the initial peak of hydrocarbon emission during the manifold "dry-out" period, and a further peak when the device cuts back in. The recovery, except after very severe braking, was generally satisfactory.

Further improvements in driveability of some car installations were made through the inclusion of engine speed sensing and throttle position switches.

Various forms of positive idle fuel shut-off valves combined with the idle mixture adjusting screws have also been under consideration. The ease with which this device could replace the original adjusting screw on some carburetors made it very attractive. The major problems encountered with this device were:

a. Incomplete fuel shut-off. If the idle discharge hole is closed, in most carburetors some fuel will flow from the idle transfer holes.

b. Possible misalignment of valve and seat.

c. Problem of maintaining idle mixture adjustment with a movable needle valve.

d. Lack of space on new design, low-built carburetors.

Other Methods

Another way of shutting off idle fuel flow, which was tested, was to rotate the carburetor throttle

plate further in the direction of its normally closed position so that the idle feed ports would be directly exposed to the atmosphere. Thus, all idle fuel flow was effectively stopped.

Results of tests with this device showed promising reduction in hydrocarbon emission. However, if the throttle plate was fitted loosely enough to swing past the center position, it caused too large an opening in the normal idle position. This resulted in excessively high idle speed.

Flowstand tests were also made to see if the application of vacuum to the carburetor float bowl would effectively shut off the idle fuel by overcoming the pressure differential causing fuel to flow. But the necessary back suction was found to be quite critical. It caused violent bubbling in the float bowl . . . and in some carburetors slightly increased vacuum would cause fuel flow to resume.

Of all the idle shut-off devices, in fact, the air-bleed type is to be favored . . . chiefly because it doesn't have to be located directly in the idle system passages. But even with the air-bleed type, major redesign would be required for incorporation on even future model carburetors. This is true because of the increasing use of multi-bore, multiple idle systems, as well as trends toward extremely compact designs.

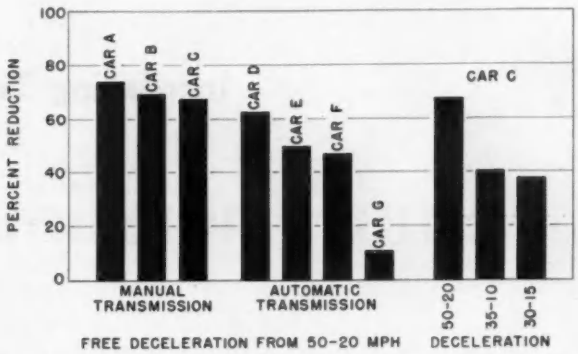


Fig. 8—Reduction in exhaust hydrocarbon emission shown with air-bleed type of idle fuel shutoff devices.

Ignition Cut-off Burner

Another device tested was one in which the ignition is interrupted during deceleration and a spark in the exhaust pipe is fired.

In tests in three different makes of cars, the reduction for decelerations from 50 to 10 mph was from 0 to 80%; from 30 to 10 mph the reduction was up to 45%. However, there was some noise associated with the operation of the device that was obviously caused by explosions of accumulated fuel-air mixture in the exhaust pipe and muffler. While these explosions apparently did a good job of burning up the fuel, the noise was not acceptable.

The noise could be eliminated by nearly closing a close-fitting heat-riser valve, insertion of many layers of screen, or by inserting other commonly used flame arresters. With the flame stabilized, it appeared to be burning steadily, but the hydrocarbon level downstream was too high. A high-speed camera was used to photograph the flame and it was found that the flame was actually lighting and extinguishing at a high rate. Further efforts to obtain continuous burning failed.

The device was abandoned, however, because no economical means was known to make it fail-safe. Malfunctioning of the igniter or other parts could cause destructive explosions in the muffler.

Other devices tested and evaluated included: a sandwich butterfly valve fuel cut-off device; a vacuum form of sandwich throttle device located between the carburetor and the intake manifold; an air-fuel regulator with fuel augmentation to promote good burning; an idle fuel shut-off by manifold vacuum means and idle fuel delivery directly at engine ports; an extra electrical energy ignition system to burn fuel during high vacuum engine operation; a device to change ignition advance during vehicle deceleration; a carburetor-poppet device in the carburetor throttle valve; and an intake manifold-air bleed device.

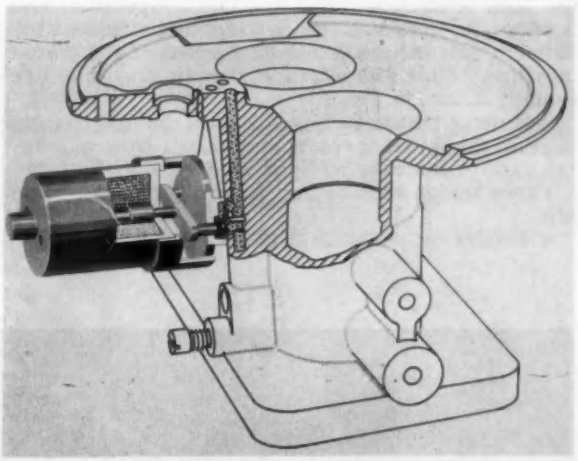


Fig. 9—Solenoid-operated positive idle fuel shutoff.

Tested also was a proposal to stop the flow of idle fuel by having a valve in the exhaust pipe completely shut off the exhaust system during the coast period. When the exhaust was completely shut off, the high back pressure produced so much leakage past the exhaust valve guides, piston rings, and other parts of the system that a fairly high air flow still existed. No effective hydrocarbon reduction was obtained by this method.

To Order Paper No. 170 . . .
. . . on which this article is based, turn to page 5.

Increasing Temperatures Spur the Search for

Compatible

Based on secretary's report by

E. F. Koenig,

Texas Co.

STEADY increase in fluid temperatures of automatic transmissions requires careful mating of the fluid to the transmission. The temperature rise is due to increase in horsepower transmitted through and the rugged service asked of the transmissions. The temperature rise in the last five years is shown in Fig. 1.

Standard transmissions are now behind 300-hp engines and must accommodate loads from passenger cars to taxicabs to light trucks.

Three major reasons for failure of transmission are:

- **Failure of mechanical parts.**
- **Internal and external leaks.**
- **Deterioration of automatic transmission fluid.**

The wrong fluid can cause any one of these failures. The fluid can react with and leak through the seals, resulting in malfunction or destruction of the unit. Unstable fluids can form deposits which prevent the proper operation of the transmission. Improper lubrication wears out parts.

The Ideal Fluid

Desirable properties in a transmission fluid include:

- Thermal stability—no sludge or varnish formation at least up to 400 F.
- Good operating characteristics—these include antifriction, antiwear, extreme-pressure perform-

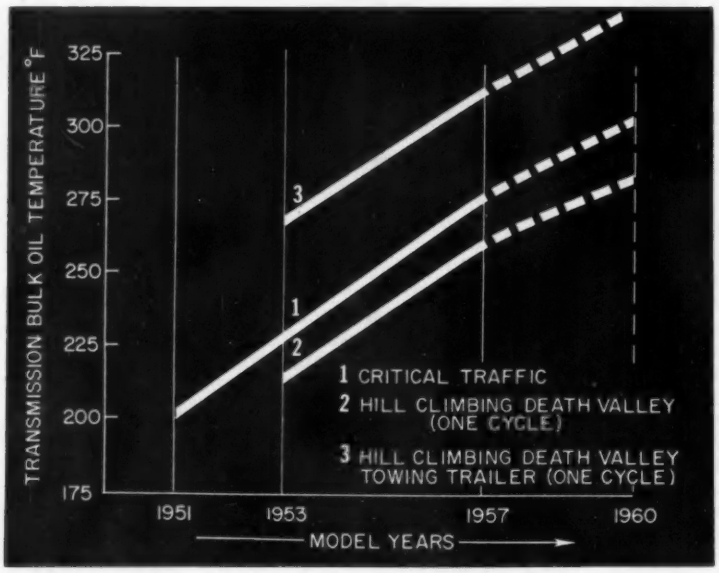


Fig. 1—Transmission bulk oil temperatures have risen steadily due to the increase in horsepower, heavier duty application, and lower styling.

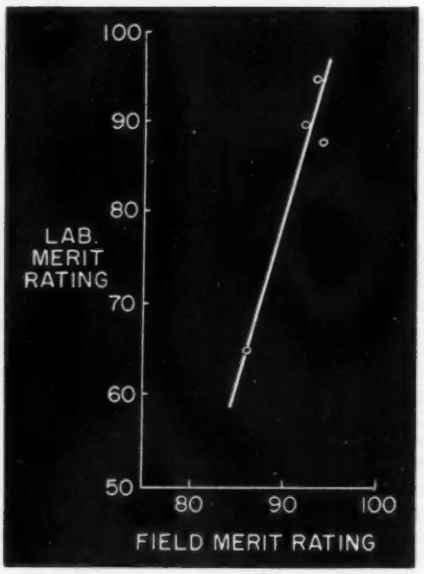


Fig. 2—Varnish and sludge build-up in field tests is compared with laboratory oil stability tests.

Automatic Transmission Fluids

ance, nonfoaming, high viscosity index, and viscosity stability for all operating conditions.

- Low pour point—for winter starting.
- Inert—no effect on seals, metal parts, or clutch materials.

Tests for Solutions

Trouble spots can be cooled off by changing transmission design or formulation of new fluids. In either case reliable test methods are needed to anticipate performance. The following methods have already shown good correlation with field service reports.

Foaming can be accurately predicted by the Detroit Transmission Division Foam Test. This test is now required as part of the Armour Qualification test for Type A fluid.

Thermal oxidation stability checks-out close using a motored type of transmission test. Running actual transmissions, such as the Powerglide or Mercomatic, is rapidly replacing the Chevrolet L-4 engine test. Advantages are low cost, similarity to field test conditions, and high-temperature operation. There is not complete correlation between all transmissions. However, good agreement on several fluids has been obtained. This test technique also gives data on fluid compatibility with bearing materials and seals.

Lowest starting temperature of the transmission is found by using a Brookfield viscosimeter. Pour point depressants are added to the fluid to decrease the starting temperature. These must be carefully evaluated since the additives may loose their effect under high rates of shear. This problem is also encountered with viscosity index improvers.

Fluid-seal compatibility remains a problem. The Beaker Seal Test, gives, for example, different results for silicone and Buna N seals. The test predicts excessive swelling and softening for silicone even though the seals performed well in actual transmissions. More correlation with field test data is needed to determine finally if this test for volume change versus aniline point should remain in the laboratory stable.

Serving on the round table, "Automatic Transmission Fluid Trends," were:

Chairman: N. A. Hunstad, Research Staff, GMC

Secretary: E. F. Koenig, Texas Co.

Members:

S. R. Calish, California Research Corp.

D. F. Miller, Chrysler Corp.

R. E. Osborne, Research Staff, GMC

R. I. Potter, Ford Motor Co.

T. W. Selby, Research Staff, GMC

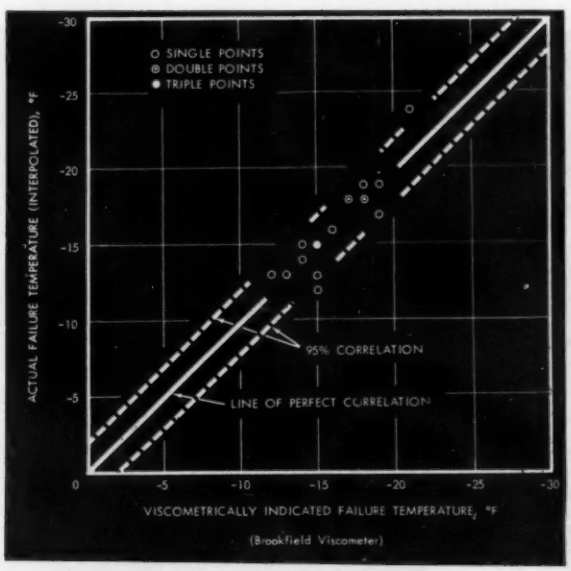


Fig. 3—Accurate prediction of lowest operating temperature before transmission failure is made with a Brookfield Viscometer.

Engineers Are Solving Exhaust Gas Pollution Problems

Hydrocarbon emission during deceleration cycle, instrumentation, and removal of hydrocarbons cited at SAE National West Coast Meeting.

ENGINEERS from all parts of the country were treated to an extensive airing of the air pollution problem at SAE's National West Coast Meeting held in Seattle August 12–16.

Among the phases discussed were the Los Angeles smog problem, hydrocarbon emission during the deceleration cycle, instrumentation for evaluating and measuring hydrocarbon emission, and the development of devices for removing hydrocarbons at the exhaust end of the engine.

Other interesting technical sessions provided an exchange of information on multipurpose lubricants and the air-cooled diesel engine.

John M. Campbell, chairman of the Vehicle Combustion Products Subcommittee of the AMA, summarized the nine technical talks on air pollution in his luncheon address, pointedly titled "Must Mechanical Horses Have Halitosis?"

He indicated that the first course of action of the automotive industry, after learning that unburned hydrocarbons and nitrogen oxides of vehicle exhausts were definite suspects in the smog battle, was to undertake a gigantic cooperative program which started with the development of means of measuring exhaust constituents.

The opening paper by J. C. Neerman and G. H. Millar of Ford Motor Co. dealt with the "Determination of Hydrocarbon Emission Rate by Continuous Airflow Measurement and Exhaust Analysis." This was followed by a report on "Development of an Integrator for Determining the Total Emission of Automotive Exhaust Gas Components," a paper jointly authored by R. T. VanDerveer, R. L. Dennis, J. D. Jenks and S. B. Smith, of Ford Motor Co.

Closely related to the instrumentation work was the paper on "Los Angeles Traffic Pattern Sur-

Paul Bunyan Day . . .

. . . was observed on Thursday of the meeting week. SAE members and guests enjoyed an all-day trip to Snoqualmie Division of the Weyerhauser Co. to see mill and logging operations and equipment, and then to Pacific Car and Foundry to see additional off-highway equipment. Here guests watch foresters bring logs in via sky-line.

vey" in which the cooperative efforts of the entire industry were reported by Dr. D. M. Teague, of Chrysler Corp.

These papers, and those which followed, according to Campbell, Scientific Director of General Motors Research Staff, are part of a concerted drive being made by the industry to learn how to deal with the difficult exhaust air pollution problem.

Two major steps leading to what is hoped will be ultimately the solution of the exhaust gas air pollution problem were spelled out in other industry reports.

Howard H. Dietrich of Rochester Products Div., General Motors Corp., in a round-up of work done by the AMA Induction System Task Group, indicated that throttle control devices and dashpots in the carburetor system can provide a substantial reduction in the amount of unburned hydrocarbons emitted during decelerations. This is considered a first step toward making the automobile less an offender in the air pollution picture.

Next major step, and probably the one ultimately necessary, will be the treatment of the exhaust gas itself, according to George J. Nebel, of General Motors Corp., reporting on the AMA Exhaust System Task Group. Some devices currently under test show promise of oxidizing about 80% of the unburned hydrocarbon. However, design criteria for a container or muffler which would carry a chemical catalyst present imposing problems of size, heat insulation, noise, and longevity, he declared.

Recent investigations by chemists point to vanadium pentoxide as a low-cost oxidation catalyst, it was reported by E. F. Hill, W. A. Cannon and C. E. Welling, of the Ford Motor Co. Scientific Laboratories. They, too, advised of the tortuous path involved in making such a catalyst effective in a production muffler.

Indicative of the broad scope of the smog battle was a report by B. M. Sturgis, of E. I. duPont de Nemours & Co., Inc., whose report on "Grab Sampling and Analysis Techniques for Exhaust Gas" was a result of phases of the cooperative research program in which the CRC is combining the efforts of automotive and petroleum technologists.

Supplementing the intensive

SAE PRESIDENT W. PAUL EDDY (seated, left) relates a humorous experience to John Conti (seated, right), John A. C. Warner (standing, left), and Lee Ketchum. Conti is Vice-Chairman of Northwest Section. Warner is Secretary and General Manager of SAE. Ketchum was General Chairman of the West Coast Meeting.

THE SAE NATIONAL WEST COAST MEETING got off to a good start on Monday August 12. Total attendance for the meeting ran close to 400.

Lee Ketchum, General Chairman of the Meeting, and **W. Paul Eddy**, SAE President, welcomed the engineers to the first session.

The five-day program featured 26 technical papers, 4 luncheons, an evening banquet, and inspection trips to Boeing Airplane Co., Weyerhauser Co., and Pacific Car and Foundry.

Thursday was set aside as Paul Bunyon Day with SAE members and guests traveling into the Cascade Mountains to watch crews log in virgin timber. Interest was about evenly divided between the logging equipment and the logging operation.

Engineers left the meeting Friday evening for return to their home bases, some as far away as the East Coast. Almost all felt they were returning home with some new knowledge gained as a result of the meeting.

Britt Smith

Bill Muncey

John Holmstrom

W. W. Churchill

G. A. Bowie

I. H. Lewiten

J. M. Campbell

Four lunches and a banquet . . .

. . . were held as part of the 1957 SAE National West Coast Meeting.

Monday's luncheon speaker was John Holmstrom of Pacific Car and Foundry Co. He recalled the early days of automotive engineering on the west coast and the struggle with body manufacturer and operator that has brought about the present heavy-duty truck.

Tuesday's luncheon speaker was Bill Muncey who was the driver of the winning boat at the Gold Cup Races in 1956 and 1957. Muncey gave SAE engineers an education in race boat driving and told why some drivers were winners and why some were not.

Wednesday's luncheon speaker was I. H. Lewiten of Weyerhauser Co. Lewiten discussed the need for farming the forest to protect our natural resources.

Friday's luncheon speaker was J. M. Campbell of General Motors Corp. and Chairman, AMA Vehicle Combustion Products Subcommittee. Campbell discussed air pollution problems and the progress that has been made in combating these problems.

Britt Smith, 1956–57 Northwest Section Chairman, acted as toastmaster for all of the luncheons.

At the Banquet G. A. Bowie of Firestone Tire and Rubber Co. was guest speaker. Bowie discussed human psychology and gave a lesson on working with your fellow man.

W. W. Churchill was toastmaster at the banquet.

work on hydrocarbon emissions, Dr. Fred W. Bowditch, General Motors Corp., in a paper presented by title only, described the industry's development of a photographic guide for enforcement officers, and a color motion picture for training purposes to help police, judges, and other officials to recognize unnecessary vehicle exhaust smoke emissions. Campbell showed the motion picture to the luncheon group.

Along with this, Don G. Fowler, Chrysler Corp., described the development of a test procedure for measurement of carbon monoxide in automobile passenger compartments, an assignment recently completed by a special AMA group.

S. Smith Griswold, the Los Angeles official, in the discussion said that he was very much impressed with the automotive engineering progress which is expected to help in the smog problem.

Benjamin Linsky, the San Francisco air pollution control official, said that in his community, with about half the population of Los Angeles and approximately the same area, the smog situation now is between one-third and one-half as bad. He predicted that many communities would have to fight this battle as the concentration of air pollutants increases.

New Additives Improve Multipurpose Greases

New additives in the lithium 12-hydroxystearate multipurpose greases provide:

1. More complete metal wetting.
2. Better protection against corrosion in the presence of free water.
3. A moderate increase in load-carrying properties.

These improvements have been achieved without reducing the multipurpose characteristics of the greases.

Future multipurpose automotive greases, SAE members and guests were told, will probably extend the high-temperature ceiling. New high-melting organic and non-melting inorganic grease thickeners are expected to supply the improvement.

Logging operators are looking for simplified lubricant recommendations for their equipment. The high and costly inventories they are now required to carry to meet various types of service plus the increased possibilities of dirt getting into lubricants and of service men using the wrong lubricant are responsible for the plea.

For example, one logger now uses 198 inventory items of motor oil. He speculates that ultimate simplification of lubricant requirements, through the use of multipurpose, multiviscosity oils, could bring inventory to a minimum of 44 items.

Enthusiasts Cite Air-Cooled Diesel Advantages

Adherents of the air-cooled diesel engine see the following as advantages over the water-cooled counterpart:

1. More efficient operation over a wider range of ambient temperatures.
2. Needs less preparation and a shorter starting period in cold climates.
3. Lower specific fuel consumption due to higher cylinder and cylinder-head temperatures.
4. Greater durability of the engine and less cylinder wear—a direct result of the shorter warmup period.
5. The ability to be started and stopped frequently and run for long periods of time at loads as low as 15% of maximum rated output, without structural or physical damage.

Inspection Trips Popular with Members

Many members took advantage of the inspection trips set up as part of the meeting program. Well attended was an inspection trip to the Boeing Airplane Co. Many of the wives joined their husbands in inspecting the Renton Plant where they saw large bombers and new jet transports being built and tested.

Also popular was an all-day trip to Snoqualmie Division of the Weyerhauser Co. to see mill and logging operations and equipment, and then to Pacific Car and Foundry to see additional off-highway equipment.

A luncheon in the View Room of the Seattle Tennis Club was the highlight of entertainment arranged for the wives of engineers attending the meeting. While their husbands visited the logging operation, the SAE wives enjoyed a pleasant afternoon in the club overlooking Lake Washington.

SAE PRESIDENT W. P. EDDY records a pleasant sight on the Paul Bunyan Day trip to Weyerhauser Co.

SAE PRESIDENT W. PAUL EDDY presented to General Chairman E. E. Bryant a plaque in recognition of Bryant's work in developing the successful Farm, Construction, and Industrial Machinery Meeting. Bryant is president of Nelson Muffler Co.

TECHNICAL SESSIONS of the meeting were developed under the direction of SAE Vice-President W. W. Henning and Meetings Vice Chairman K. L. Magee of the Tractor and Farm Machinery Activity.

Earth-

To Hold

IN this era of rising prices, both earthmoving and tractor engineers are helping to flatten the cost curve for users of their vehicles. Improvements in earthmoving equipment, for example, have permitted highway departments to mechanize in such a way as to reduce highway maintenance costs per 1000-vehicle-miles by 32% in the last decade. And tractor technicians are facilitating operations for their users by increasingly effective application of automatic transmissions and hydraulic systems, by current progress in 3-point hitch and lubrication standards, and by design leading to easier and cheaper maintenance.

Advanced manufacturing techniques, making feasible many of the design changes, have played an equal part in providing vehicles with which users can combat inflation in operating costs.

The achievement of all groups, it was brought out at the SAE National Farm, Construction, and Industrial Machinery Meeting, is being facilitated by increased attention to solution of "human engineering" problems . . . both in developing designers and in adapting vehicles to the men who must use them.

Earthmoving Contributions

The favorable effect on highway construction costs of relatively stabilized earthmoving costs points up the equipment engineers' contribution toward a less inflationary economy.

The engineers have produced earthmoving equipment which

Moving Units Help Living Cost Lines

makes it possible for highway construction men:

- To build in highway features during construction which reduce maintenance effort.
- To use modern equipment in maintenance operations.

One such feature is raising grade lines above the adjoining topography and streamlining side slopes to prevent accumulation of drift snow. Just this improvement, a recent statewide survey shows, could reduce annual snow removal costs from $220 to $11 per mile. In the St. Lawrence project alone, recently improved earthmoving equipment has made major contributions. (One large piece of equipment used to excavate and toss material into a stockpile weighed 650 tons and had a 165-ft boom. . . . It was called "The Gentleman"!)

The earthmoving equipment engineer has been making these contributions to more economical use in the face of more than a few hurdles. Even after latest improvements get into a crane, for example, its user's troubles are only starting. He finds it very expensive in some states, for instance, to move the crane to its place of work. . . . Permits, licenses for the carrier or chassis weight, and other special licenses and local regulations often must be surmounted.

The torque converter is one of the improvements some designers are finding ideally suited for shovel cranes. One engineer at the meeting named what he considers eight specific advantages for the hydro-kinetic torque converter over direct engine drive in shovel-crane applications.

The perennial attempt to make maintenance easier continues, too. Recent progress is being reported from cooperative effort by a group of engineers working together as a subcommittee of the SAE Construction and Industrial Machinery Technical Committee.

Reported at the meeting also were geometry changes in self-propelled scraper designs which result in easier and faster loading and unloading. One such change was in a gooseneck connection to an octagonal section, where the upper and lower plates were extended to wrap around the octagonal section. In addition, the top and bottom reinforcing straps of the draft frame arms were extended to wrap around to the center of the octagonal section.

Tractor Design Goes Forward

The infinitely variable torque-multiplying transmission has revealed characteristics in earthmoving equipment operation which are now attracting favorable attention from tractor engineers. Earthmoving-equipment experience led a prominent tractor engineer to say at the Meeting that such automatic transmissions "can be successfully applied to farm units."

Improved stress analysis was also emphasized as currently contributing to better tractor design. One group of engineers reported that use of brittle lacquers and wire resistance strain gages has enabled them to determine oper-

Nearly 2000 earthmoving-equipment, tractor, and parts engineers gathered at Milwaukee's Hotel Schroeder on September 9–12 for what this year was the SAE National Farm, Construction, and Industrial Machinery Meeting and Production Forum (formerly SAE National Tractor Meeting and Production Forum).

The Meeting continued the upward trend in attendance and activity which led the SAE Meetings Committee, some months ago, to plan expanded facilities and features in 1958 for this outstanding SAE event. Next fall, the needs of the engineers in this fast-growing segment of SAE will be met by:

- **USE OF MILWAUKEE AUDITORIUM** as the site of technical sessions for the SAE 1958 National Farm, Construction, and Industrial Machinery Meeting.
- **Addition of an Engineering Display,** open throughout the 1958 Meeting to supplement the technical papers. (The display will also be held at the Milwaukee Auditorium in space adjacent to the technical sessions.)

This year's meeting, forerunner of the 1958 expansion, was held under the general chairmanship of E. E. Bryant, Nelson Muffler Co. The Production Forum had R. G. Krueger, Power Products Corp., as Sponsor, and R. M. Bruesewitz, Power Products Corp., as general chairman.

The technical program was developed by the sponsoring Activities. SAE Vice-President W. W. Henning of the Tractor & Farm Machinery Activity has K. L. Magee as meetings vice-chairman. SAE Production Activity Vice-President J. E. Adams has Anderson Ashburn as meetings vice-chairman.

Milwaukee Section cooperated actively with the General Committee in local arrangements, Section Chairman E. H. Panthofer serving as a member of E. E. Bryant's General Committee. Reception chairman was J. P. Kelly; Publicity chairman was F. J. Hartshorn, Jr.; and Robert Carlin was Membership chairman.

HERBERT A. LEGGETT (left) was the principal speaker at the Luncheon which was a highlight of the meeting. With him are Toastmaster Kenneth Haagensen, Allis-Chalmers Mfg. Co., and Milwaukee Section Chairman, E. H. Panthofer.

ating loads and stresses in parts and assemblies for which theoretical analysis is too difficult. The measurement of loads in the field, another group emphasized, is just as important as the measurement of stresses. With working loads known, they conclude, the basic structure can be designed satisfactorily with the minimum safety factor.

Tractor engineers, too, are still working hard at ways to improve maintenance. And, like the CIMTC group, they are working partly on a cooperative basis.

One recent study of 60 tractors, financed by a farm supply company, revealed to the Agricultural Engineering Department at University of Illinois five ways to improve tractor maintenance. As reported at the Meeting, the five ways were: (1) eliminate as many maintenance chores as possible by basic design; (2) design tractors for easy, quick maintenance chores, when the chores cannot be eliminated; (3) examine every recommendation to see if time intervals are realistic; (4) standardize recommendations and improve the general level of maintenance manuals; and, (5) keep working to educate the farmer on tractor maintenance.

Many tractor engineers look toward continued improvement of hydraulic systems as a major contribution to better tractor design. Emphasis at this Meeting was on relating more accurately in a particular design the special advantages and disadvantages of an individual hydraulic system. "We should remember," one engineer warned, "that engineering is a tool of compromise . . . and where a design has weak characteristics, it usually has favored another to provide a strong feature. So it is necessary to weigh characteristics and determine what effect they have on a particular application. . . . Many so-called disadvantages can be made into advantages by the opportunist designer."

Throughout the Meeting, ideas were exchanged about how to train engineers—and apply their talents to jobs where they will be most effective.

"Where can we get satisfactory supervisors," the production men were asking each other for several hours on the Meeting's opening day. Then an experienced engineering executive, later in the Meeting, sparked discussion with his own answers to questions like: "What does industry expect of a graduate engineer? What may the graduate expect from industry?—And what are the characteristics of a good product engineer?" . . . And still later, the assembled engineers were warned of the necessity to think of the "driver" when designing their earthmoving equipment and farm tractors.

The way specifically suggested to do the thinking about the vehicle user was "experimental psychology." False notions about people brought out by a psychologist included:

"Some designers assume operators to be like themselves. Others think people to be morons in the handling of equipment. . . . Similarity of operators is another assumption. . . . No one believes these assumptions, but, we act as if they were true. Individual differences are too often ignored."

THE CHAIRMEN of two SAE Student organizations in the Milwaukee area represented SAE's ever-growing Student activities as guests at the speaker's table of the Meeting's luncheon. They are (left to right): Frank Spexarth, Marquette University, and James Price, University of Wisconsin.

NEWS of the
Farm, Construction, and Industrial Machinery
PRODUCTION FORUM
Sept. 9-10, 1957 Hotel Schroeder Milwaukee, Wis.

Cost Cut Data Exchanged Freely

at 1957 Production Forum in Milwaukee

EFFECTIVE planning paid off again at the 1957 Production Forum of the National Farm, Construction, and Industrial Machinery Meeting in Milwaukee. Developed under the auspices of the SAE Production Activity Committee, the Forum this year had as sponsor R. G. Krueger, works manager of Power Products Corp., and as general chairman, Power Product's superintendent, R. M. Bruesewitz. The Forum sessions of this year's meeting were held September 9 and 10.

Sessions on heat-treating and supervision selection attracted particularly enthusiastic audiences. In each instance, the panel leader was obliged to close the meeting while the audience was still eager to continue the lively discussions generated.

Included in this year's meeting were sessions on heat-treating techniques; small gasoline engine manufacturing techniques; production planning and inventory control; welding methods and process control; factors in gear and spline production; supervision, selection, training and performance evaluation; automation; cost reduction and control techniques; and on quality control.

Questions asked and answered during the panel sessions emphasized ways and means for holding the line on production costs despite spotty production schedules.

MEN RESPONSIBLE for the successful Production Forum were Forum Sponsor R. G. Krueger, Power Products Corp. (right); R. M. Bruesewitz, Power Products Corp. (left), who was general chairman of the Forum; and (center) SAE Vice-President representing Production Activity, J. E. Adams.

Supervision Key to Employee Attitudes

FOUR simple rules were offered at the "Supervision Selection, Training, and Performance Evaluation" panel for successful introduction of a sound employee evaluation plan:

1. Define accurately the purpose for which the evaluation is being made.
2. Develop a simple and acceptable operating and followup plan.
3. Take line supervisors into your confidence and explain what the plan is all about.
4. Try to instill in your employees an attitude that will make the plan workable.

The usual tools for employee evaluation were considered during the discussion, including the application blank, psychological tests, and the interview. Among other things pointed out was that the interview should be purposely used to "plug the holes" left by other evaluation methods.

A recent survey by the University of Michigan evaluating the capabilities and attitudes of employees of a well-

known appliance manufacturer was cited as an example of the kind of evaluation work that has produced very satisfactory results. Following evaluation and promotion to a position of higher responsibility, even employees who had later to be returned to rank-and-file as a result of production cutbacks, had better working attitudes.

In every work situation, it was emphasized, there is a potential for growth of the individual employee that ought not to be neglected.

Industry may be paying a severe penalty for its failure to develop proper working attitudes among employees. . . . And this is a line function; not a responsibility that staff employees can assume.

The wisdom of promising college graduates "too much and too soon" was recognized as a temptation—but deprecated as a policy. One discusser said that one of his best sources of recruiting is disillusioned and saddened young college graduates who were led to expect far too much by recruiting representatives.

Fred Roberts, Chesapeake & Ohio Railway Co., was leader of the supervision selection panel. R. H. Hamilton, also of the C. & O., was secretary. Panel members included John Conway, A. O. Smith Corp.; Ludwig Huttner, Stevens, Thurow, & Associates; J. R. Niven, Boeing Airplane Co.; A. K. Van Tine, Owens-Illinois Glass Co.

Wear Resistance Up On Small Engines

THE small engine industry is looking for new ways to protect cylinder bores that will not require liners and yet will give adequate resistance to wear, according to discussion at the "Small Gasoline Engine Manufacturing Techniques" panel.

New anodizing techniques for aluminum and hard and soft chrome-plated finishes were described in detail. A plated hard-chrome finish is reported to give excellent wear resistance under many service conditions.

A thorough briefing was given at this panel on self-tapping studs . . . also on inserts, which have recently been used with considerable success in die castings by the automobile and other industries. These new vibration resisting devices can be readily inserted—and reports indicate excellent resistance to shear and good field service characteristics.

An interesting recent application mentioned is use of a self-tapping insert for spark plugs by a prominent producer of small engines.

In discussion of the relationship of porosity and pressures in die casting, use of high die-casting pressures on small parts and low die-casting pressures on large parts was suggested.

The step-by-step production of a small engine crankshaft was also described, as was spraying of cylinder walls with molybdenum to increase wear resistance.

F. J. Stuckert, Briggs & Stratton Corp., was chairman of this panel, and J. G. Boehm of Briggs & Stratton served as secretary. Panel members included A. Linn, Metal and Thermit Corp.; Howard Schweppe, consultant; Frank Ferguson, Aluminum Co. of America; W. Bohman, Wisconsin Motors.

Other-than-labor Costs Key to Reduction Hopes

SIGNIFICANT at the "Cost Reduction and Control Techniques" panel was the observation that there has been a general increase in labor costs of 50% since 1951. Nevertheless, cost reduction programs, to be effective, should be aimed at practically every phase of a company's operation: engineering, purchasing, accounting, materials handling, and the rest. The advice given was:

"Don't restrict yourself to investigations of **direct** labor savings if you want to cut production costs."

"Brainstorming" also was mentioned as having helped many companies to reduce costs. Advice given to those who consider use of brainstorming techniques included:

1. Narrow down your area to a specific problem.
2. Take steps to insure positive, open-minded discussion.
3. Be enthusiastic about the "brainstorming" approach to your problem.
4. Be perceptive; look in unusual places for your ideas rather than directly at the subject under discussion.

Discussion of suggestion plans brought out that, in some plants, as much as 70% of the acceptable suggestions come from supervisors rather than from line employees. A large automobile firm reports paying four to five times as much to supervisors as to workers under its suggestion plan.

Monetary rewards for suggestions seem to be getting less emphasis these days. One unheralded benefit of a suggestion plan may be its value as a means of communication.

"Accentuate the positive" may be a good idea for your cost reduction program, too, one panel member emphasized. He thinks it desirable to refer to a cost reduction program as a "profit improvement program," thereby avoiding the negative approach associated with cost cutting.

One firm reported it had generated more enthusiasm for some of its programs by seeing to it that the worker's wife was informed by letter of certain company activities and programs. In some instances, the favorable effect on the enthusiasm of the employee was noticable, it was indicated.

Leader for the cost reduction panel was Roger Hubbell, Allis-Chalmers Mfg. Co., and Panel Secretary was Joe Torcassi, also of Allis-Chalmers. Panel members were: Robert Dimberg, Allen Bradley Co.; Glenn Wolfe, Heil Co.; Allen Gaulke, Allis-Chalmers Mfg. Co.; Lynn Surles, Marquette University; Hale Whitcomb, A. O. Smith Corp.

New Gear Cutting Processes Examined

SEVERAL of the newest machines for gear cutting, gear shaving, and inspection of parts were described at the panel on "Factors in Gear and Spline Production."

While automatic setups were discussed, emphasis was on quality and on operating efficiently at desired production rates. This may be a reflection of the times, in which reduction of costs is of paramount importance.

New tools, including such items as carbide hobs, were also discussed.

Considerable attention was given to the broaching of hardened splines . . . and to the advantages and limitations of leaded steels.

Speakers placed considerable emphasis on the necessity of accurate gear blanks if tight tolerances have to be met.

Cold forming of gears and splines provoked a prolonged discussion. While cold forming methods for splines and gears are highly promising and several production installations are operating successfully, experience in this field is limited. Consequently, much of the discussion was concerned with the conditions which will permit prac-

tical use of cold forming of splines and gears.

A number of new, high-volume, fully automated gear-making machines have recently been introduced and several of these were described.

Panel leader for this group was Del Hansen, J. I. Case Co., assisted by Gordon Kousek, J. I. Case Co., secretary.

Panel members included A. S. Black, Fellows Gear Shaper Co.; Ed Ball, National Broach & Machine Co.; Ben Grob, Grob Machine Co., Inc.; S. Bjornberg, Illinois Tool Works; and L. Patchin, Gleason Works.

Low Volume Brings Automation Puzzle

AUTOMATION has created some involved accounting problems, particularly during periods when production schedules are being changed abruptly. There is no general agreement as to satisfactory methods of calculating the financial return on much of the automatic equipment in use today, it was noted at the "Have You Decided to Automate?" panel.

How to operate automatic equipment at reduced volume and satisfactory cost apparently is puzzling many plant managers.

Discussion here emphasized the need for coordinating effectively the efforts of product engineering and the machine design groups.

Considerable attention is being given to the problems of short-run automation. Interest in this phase of automation has increased noticeably in the last 12 months.

Other aspects of mechanized production that are drawing attention are: (1) use of unitized, building-block-type construction, (2) feedback controls, (3) training of maintenance personnel, (4) calculation of burden rate at lowered production rates.

Members of the automation panel included Panel Leader, J. A. Newton, Thompson Products, Inc., Panel Secretary, M. D. Braid, Thompson Products, Inc. Others were P. P. Niland, Washington University; R. L. Witche, International Harvester Co.; R. W. Truxell, Oldsmobile Division, General Motors Corp.; Fred Jessop, Cincinnati Machine Co.

Higher Temperatures Save Furnace Time

MUCH to the surprise of many members attending, high-temperature carburizing and hot oil quenching occupied most of the time of the "Heat-Treating Techniques" panel.

The discussion brought out that, for every 50 F increase over 1700 F, as much as 30 min of furnace time may be saved. This result has been achieved, incidentally, without penalties resulting from grain coarsening or severe distortion. Also, it was reported, the life of furnace parts is not adversely affected.

Where higher carburizing temperatures such as 1800 F are used, it was pointed out, grain coarsening may occur, requiring a second heating of the part for grain refinement. Even so, the total cost of the operation may actually be less than the cost of conventional carburizing at 1700 F. Some experimental work at 2100 F was also reported.

Some remarkable results were reported as a result of hot oil quenching. A midwest truck manufacturer said his company is using a 400 F oil quench with no appreciable sacrifice in tray loads and is getting improved quality and uniformity of the part. In this particular application, Rockwell C was off 2 points but this was corrected by specifying a steel with slightly higher carbon content. Quenching oil is frequently used well beyond 1000 hr—and then converted into a special grease.

By selecting jobs carefully, it was suggested, many plug and press quenching jobs can be replaced with a hot oil quench.

Also described, was use of progressive pressure oil spray quenching of a critical shaft formerly made of SAE 4340. A 45-deg angle and 20–25 psi pressure permitted use of unalloyed

Leaders of Production Forum Panels . . .

Cost Reduction and Control Techniques, **Roger Hubbell**, Allis-Chalmers; Quality Control, **R. L. Herman**, Power Products; Automation, **J. A. Newton**, Thompson Products.

Production Planning and Inventory Control, (seated) **P. A. Scheuble, Jr.**, Vapor Heating; Factors in Gear and Spline Production, **Del Hansen**, J. I. Case; Supervision Selection, Training and Performance Evaluation, **Fred Roberts**, Chesapeake & Ohio; (standing) Heat Treating Techniques. **D. J. Wright**, Caterpillar; Small Gasoline Engine Manufacturing Techniques, **F. J. Stuckert**, Briggs & Stratton; Welding Methods and Process Control, **J. J. Chyle**, A. O. Smith.

1035 for the same job. Hardness penetration is adequate and the quality and performance of the shaft are quite satisfactory, it was reported.

D. J. Wright, Caterpillar Tractor Co., was panel leader for the heat-treating session and W. E. Frank of Caterpillar was secretary. Members of the panel included R. S. Segsworth, General Engineering Co., Ltd.; H. J. Bates, Fairfield Mfg. Co.; R. F. Kern, Allis-Chalmers Mfg Co.; O. E. Cullen, Surface Combustion Corp.; D. J. Girardi, Timken Roller Bearing Co.; W. C. Hiatt, International Harvester Co.

Inventory Control

A Current Planning Aid

REDUCED and spotty production has dictated the necessity of controlling inventories more closely and industry is hard at work on this problem, the "Production Planning and Inventory Control" panel brought out.

Use of electronic data machines for controlling inventories is increasing, particularly in the larger companies, because of their greater speed and higher accuracy. Despite those advantages, however, the total overall cost of the new methods should be carefully compared with other available methods, it was pointed out.

All phases of management, it was urged, must participate today in any program that is to bring substantial results in controlling production and inventory.

Approaches to the problem suggested at the panel include:

1. Better sales forecasting.

2. Establishment of controls that reflect forecast changes more quickly.

3. Indoctrination of all members of the management team in the need for adequate production controls.

This suggestion was offered:

If arithmetic control computations are now being made by more than 10 employees and the electronic machine can be made to serve more than one department, it may pay to investigate the possibilities of electronic machines. To put it another way, if you can find work for a computer, say, in the accounting, production, and inventory control departments, and more than 10 people are involved, it may pay you to look into some of the new electronic equipment for controlling inventories.

An outstanding advantage of the machine method, it was pointed out, is ability to speed up inventory reports.

Panel Leader for this session was P. A. Scheuble, Jr., Vapor Heating Co.; panel secretary was T. H. Grede, Keystone Pipe & Supply Co. Panel members were J. S. Ross, A. O. Smith Corp.; Bert Lynn, A-C Spark-Plug Division, GMC; B. A. Cummings, Thompson Products, Inc.; W. J. Jones, Chrysler Corp.; T. S. Wilmeth, Scott Industries.

CO_2 Welding Advantages Aired

AS expected, CO_2 welding got considerable attention at the "Welding Methods and Process Control" panel. Advantages of this method were said to include:

1. High deposition rate.
2. Deep penetration.
3. Sound welds under difficult conditions.

In discussion of the welding of nodular iron, it was pointed out that, up to the present time, most welding of nodular iron is for repair work. Little fabrication is being done. However, a joint committee of the American Welding Society and the American Association of Foundrymen is currently studying the problem.

Also, gas welding was said usually to be preferable for either cast iron or nodular iron. A preheat of 1100 F is sometimes used, followed by slow cooling. Electrodes containing 55% Ni have been used successfully with a preheat of 300 F.

The training of welders was also considered. Among other things, it was indicated that, where incentive pay is offered, weld quality may suffer and adequate supervision is a "must."

One firm is solving its welder training problem by maintaining a staff of welding instructors. This largely eliminates the need for foremen to instruct on the job.

Another plant has a leadership course where ambitious workers are given a thorough background in welding. Many of these men later move on to important supervisory jobs, it was indicated.

Projection welding may, eventually, replace a number of plug welding applications as well as some riveting applications, it was predicted.

Chairman of the welding panel was J. J. Chyle, A. O. Smith Corp.; Albert Dearing of A. O. Smith was panel secretary. Members of the panel were T. J. Russel, International Harvester Co.; Walter Edens, Allis-Chalmers Mfg. Co.; Clyde Burgston, Welding Division, Deere & Co.; Harold Baldwin, LeTourneau-Westinghouse Co.; Del Brugioni, Caterpillar Tractor Co.

Inspection Costs Vary From 7 to Over 50%

INSPECTION costs vary from 7 to 20% of production costs, it was noted at the "Quality Control" panel. Sometimes, they reach 50% . . . or sometimes even more in certain aircraft and electrical goods plants, for example.

Discussion again emphasized that quality control is highly effective "preventive medicine." "Analyze carefully and then feedback," was the advice given.

A usually obscure fact emphasized was the number of "hidden" costs that plague the average business. Included in these not-so-obvious charges are the penalties—usually paid later on—for poor planning to obtain quality, extra and unnecessary assembly costs, customers that may be lost because of dissatisfaction with quality. Responsibility for quality is assumed most successfully it was said, by management rather than by production. Setting up sound quality control systems may require many investigations during processing. Usually, however, this effort is justified.

A good tip: "Be sure to tie back inspection to responsible supervisors."

The unreliability of customer complaints was deprecated as a measure of quality. Some customers, it was explained, are prone to complain about almost everything they buy. Others will quietly change to another source without complaining.

The problem of establishing acceptable quality levels provoked prolonged discussion from the floor. A suggestion that got considerable attention was offered by one firm which makes six prototypes of each new product. These prototypes are then reassembled so that 36 assemblies are made. In each case, variations are carefully measured. On the basis of these variations, quality levels are established.

Is quality control paying off? Most firms believe it does. But it is often difficult to establish the true savings.

Participating in the quality control panel were Panel Leader, R. L. Hermann, Power Products Corp., and Panel Secretary, A. E. Jakel, quality control consultant. Members of the panel, were L. K. Vollenweider, Deere & Co.; A. J. Spelich, Waukesha Motor Co.; E. Schmit, Allis-Chalmers Mfg. Co.; J. R. Parker, A. O. Smith Corp.

Judy McCormick RETIRES

Completes 47 years of service. Plans travel abroad next year . . .

Judy McCormick has retired from the SAE headquarters staff.

After 47 years of service to a constantly growing SAE membership, she plans, among other things, to make her first trip to Europe sometime during 1958.

She first came to SAE and its 519 members on December 19, 1910. She was hired by Secretary and General Manager Coker F. Clarkson on a temporary basis. She leaves a Society of more than 23,000 members, many thousands of whom are her personal friends.

Honored by the SAE Council at completion of 45 years of SAE service during SAE's Golden Anniversary celebration, Judy McCormick was feted by her fellow staff members on the occasion of her retirement.

With the entire headquarters staff gathered to wish her well, she was the recipient of a large plaque, signed by each staff member, which bore a message expressing the sentiments of all. The message read in part:

"Upwards of forty-five years ago, you signed up as 'temporary help' on the SAE Staff. Coker Clarkson found you in a basket on his doorstep and smuggled you into his shop to help get us going. That must have been on or about eight o'clock on a Monday morning, maybe on December 19, 1910. The weather was warm and bright. At least for SAE it was!

"You must have made good, for here you are, on August 22, 1957, with ample proof that ofttimes there's nothing as permanent as a 'temporary arrangement.'

"Along with many other accomplishments, you have selected and raised hundreds of fine men and women into our staff-family. You have so impressed your boys and girls with your spirit, philosophy and straight-line leadership that they and their children have repeatedly come to you for assignments and guidance.

"Nobody but you can ever lay claim to your own amazing record of getting things done, packages wrapped up and advances achieved.

"You have taught all of us, by your example, a great big lesson in devotion and faithfulness to the organization and its aims. You have gained your objectives for SAE regardless of personal convenience and comfort. Unselfishly, you have been ever thoughtful of others along the way."

Inhibited Thinking Is a Curable Disease

Based on paper by

COM. GEORGE W. HOOVER
United States Navy
(Presented before SAE Philadelphia Section)

THE inhibited thinking, which limits the productiveness of so much research and development, is a curable disease. It stems from a variety of sources, including:

- Lack of imagination (which results in a lack of foresight;
- Fear of ridicule;
- A "Not-Invented-Here" opposition to ideas from other inventors;
- Need to meet deadlines or cut costs (by holding modification of tools and dies to a minimum);
- Too much reliance on intuition and invention.

Making certain that every project is started with a complete statement of the problem can have important curative effects.

Treating each problem as an entirely new one is another sound basis for a cure. Inhibited thinking declines when researchers stop modifying modifications; attack the fundamentals of each problem . . . recognize the truth of Francis Bacon's statement:

"It is idle to expect any great advancement from the indrafting of new things upon old.

"We must begin anew from the very foundation, unless we would revolve forever in a circle with mean and contemptible progress."

This scientific approach, first stated in 1602 and taught in every science course in every university, is too often forgotten by engineers when they get into industry. Too often they seek for partial solutions, rather than the ultimate solution called for by this classical approach. Too often, they concentrate on keeping their heads out of the clouds; take pride in "keeping their feet on the ground" . . . which is all right provided their feet don't get stuck in the mud.

The cure for inhibited thinking involves also recognition of research as determining the path, and development as the following of it . . . of research starting with a statement of a problem in its fundamental terms; of development as application in practical terms of the phenomena resulting from the research.

Engineers who are able to think uninhibitedly can make research and development progress a continuous series of major breakthroughs. They will not be satisfied to advance only in small increments. And they can think without inhibitions if they will:

- Take the time to state each problem at hand in its fundamental terms, and
- Look at each problem as a part of a system—not as an entity in itself.

From this approach, more positive results are likely to come—particularly in the encountering of fewer blind alleys.

To Order Paper No. S19 . . . on which this article is based, see p. 5

Hydraulic Systems Packaged for Missiles

Based on paper by

A. L. STONE
and
J. W. WOODWARD
Vickers, Inc.

HIGH-DENSITY requirements and the short operational life of missiles suggest using just the operational parts of standard hydraulic system components in a single housing with only one set of mounting provisions and incorporating most of the system plumbing in the form of drilled or cored passages within the housings.

This philosophy provides several important advantages, among them:

1. Single source responsibility.
2. Component compatibility.
3. Reduced weight.
4. Greater system efficiency.
5. Minimum envelope.
6. Greater system performance.
7. Reliability through use of minimum piping; cartridge assembly techniques for ease of installation and servicing.
8. Multiple use of some parts and interacting use of others.

Packaging provides minimum specific weight and specific volume, limited only by the experience and ingenuity of the designer.

Packaged hydraulic systems being engineered today for missiles not only power flight controls, as early missile hydraulic systems did, but also drive alternators and jet engine starters too. Where a liquid-propellant turbine is the source of propulsion power, fuel pressurization, fuel control, and turbine-speed control can be added to the list of the hydraulic system's functions.

To Order Paper No. 214 . . . on which this article is based, see p. 5

Programming Is Key To Cutting Lead Time

Based on paper by

RALPH MEDROS
Aircraft Gas Turbine Division,
General Electric Co.

THERE are four basic steps in the management process of charting design and production of a new jet engine, or most other products, where it's important to minimize lead time. They are:

1. Define your objective.
2. Plan your program and implement it.
3. Measure your progress.
4. Compare your progress with your timetable.

Setting the objective is all-important. Organized activity must have an objective to motivate and guide it. Once defined, it must not be allowed to become lost in the complexity of the activity.

The operating program must be reasonable in its requirements and consistent with available resources. It should be revised constantly to conform to changes in objective or circumstances. The broad program sets forth important bench marks, calculated in units of time according to the kind and volume of activity each section must contribute. The problem of having the right things in the right amounts at the right place at the right time is solved largely by each major segment of the organization programming its course of action in accordance with a common program.

There should be a more or less mechanical procedure for reporting performance periodically to the coordinating authority. Reports should follow these rules to be valuable:

1. Progress should be stated in units of measurement identifiable with the program.
2. Reports should be condensed progressively as they move up in the organization. Higher management should get summaries of collected information.
3. Collecting statistics as an end in itself is wasteful and expensive.
4. Reporting should be frequent enough to prevent wide deviations from the program to occur before detection, yet not so frequent as to minimize changes and burden the units with reporting.
5. Reports must be timely. Indication of approaching problem areas today is more valuable than a detailed report of the situation eight weeks later.

Comparing progress with the plan is

Continued on page 120

SAE CEP
COOPERATIVE ENGINEERING PROGRAM NEWS

Simplified Lubrication Studied By Ease of Maintenance Group

SOLUTIONS to major lubrication problems are being sought by the Ease of Maintenance Subcommittee of the Construction and Industrial Machinery Technical Committee as a result of information obtained through an industry-wide survey. Subcommittee Chairman R. W. Beal reports that an effort is being made to accomplish the following:

- Establish standard lubrication periods.
- Establish a minimum number of different types of lubricants.
- Prepare standard nomenclature and description for each type of lubricant.
- Design a lubrication guide to be mounted on machinery.

The survey was circulated to both civilian and military users, although most of the information volunteered came from civilians. Information was secured on lubrication procedures for approximately 800 machines now used by single operator-owner and fleet operator alike.

Lubrication Periods

On the basis of data obtained, the Ease of Maintenance Subcommittee is developing a uniform lubrication schedule for different types of equipment. The maximum unattended period which each type of lubricant or lubricant application could endure and still insure satisfactory performance is being explored.

Types of Lubricants

The subcommittee recommends use of a minimum number of different lubricant types. Currently under study are engine oil, multipurpose grease, multipurpose gear lubricant, exposed gear lubricant, high - temperature grease, track-roller lubrication, and regular gear lubricant (straight mineral).

Machinery Mounted Lubrication Guide

The survey reflected a desire on the part of users to have machinery equipped with a permanent lubrication chart mounted on the machine. The guide considered by the subcommittee would not replace instructions furnished by the manufacturer, but would include information on lubrication frequency, type of lubricant required at each lubrication point, number and location of fittings and lubrication points, and quantity of lubricant (if required).

Color Coding

Although a majority of users favor a color code as part of a lubrication guide, the subcommittee does not recommend color coding because of difficulties in preserving and cleaning color markings. Colored discs or other marking devices might also be lost or misapplied during normal maintenance.

The Ease of Maintenance Subcommittee plans to include lubrication standards in the 1958–1959 Handbook. The group will also undertake studies on the following: grease fittings and recess holes; drain, level, and filler plugs; quick disconnects and fasteners; component arrangement for ease of adjustment, repair, and replacement; and unit assemblies versus individual parts.

Members of the Ease of Maintenance Subcommittee not shown below are: Subcommittee Secretary R. C. Navarin, Engineer Research and Development Laboratories; H. H. Bidwell, Allis-Chalmers Mfg. Co.; L. S. Burns, Barber-Greene Co.; W. P. Edwards, Le-Tourneau-Westinghouse Co.; A. G. Heisel, Caterpillar Tractor Co.; H. V. Parsley, International Harvester Co. Consultants and Liaison Representatives not shown below include the following: A. H. Nolan, Engineer Maintenance Center, and H. C. Wuestenberg, Austin-Western Construction Equipment Division.

To Order Paper No. 180 . . . on which this article is based, see p. 5

Beal Reports on Lubrication Procedure Survey

CHAIRMAN R. W. BEAL (second from left) reported on the activities of the Ease of Maintenance Subcommittee at the National Farm, Construction and Industrial Machinery Meeting and Production Forum held September 9–12 in Milwaukee. Shown with him are several subcommittee members; (l. to r.) Prof. J. A. Weber, University of Illinois; W. C. Burton, Warner and Swasey Co.; Elmer Kemp, Euclid Division, GMC; Chairman R. W. Beal, U. S. Army Engineer Research and Development Laboratories; and George Mork, Bucyrus-Erie Co.

New Absolute 15-Micron Airplane and

A NEW absolute 15-micron filter specification has been developed to improve performance of hydraulically powered flight control systems for airplanes and missiles. More accurate component response will result from use of the ultra-fine filter specification which promotes absolute control of 15-micron contaminants and permits operation at temperatures from – 65 to 275 F.

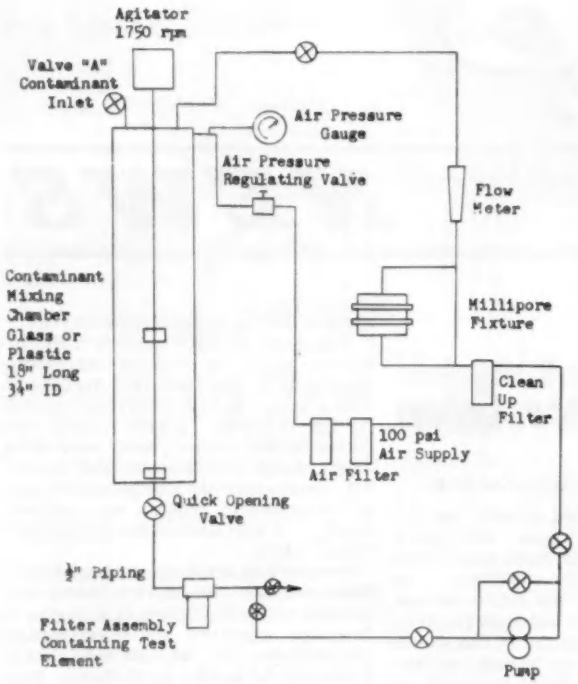
Increased use of close-lapped slide valves, particularly hydroelectric servo valves, prompted the Filter Panel of Committee A-6, Aircraft Hydraulic and Pneumatic Equipment, to develop the new specification which has been designated MIL-F-8815.

Filters built to the new specification will not pass *any* particles larger than 15 microns. Removal of approximately 95% of all particles over 5 microns is assured.

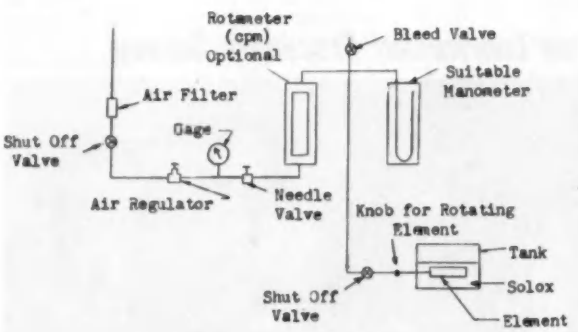
(Use of the largest particle size to designate the filter is a departure from previous practice. The old specification, MIL-F-5504, requires 98% removal of all particles over 10 microns, but exercises no control over the largest particles passed in the remaining 2%. MIL-F-5504 filters have been known to pass particles in the 50-micron and larger range.)

The new filter (MIL-F-8815) will function in the – 65 to 275 F (Type II) temperature range. MIL-F-5504 limits operation to the – 65 to 160 F (Type I) range.

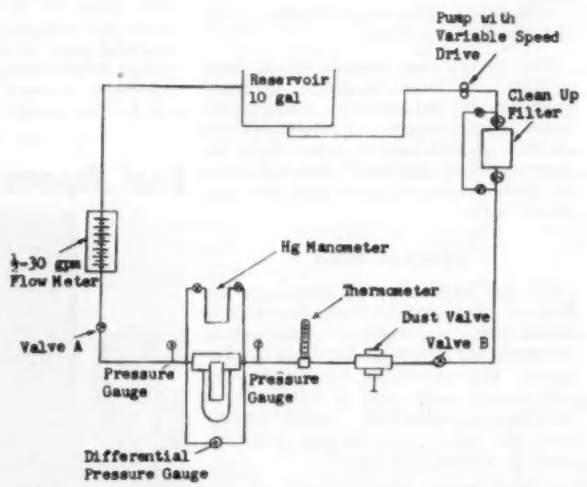
F-9 glass beads are prescribed as a contaminant for



DEGREE-OF-FILTRATION TEST SETUP—is shown with cleanup device attached. A constant flow at minimum pressure differential of 20 psi across millipore filter assembly is established and maintained for 30 min. Pressure drop across millipore fixture is recorded at beginning and end of flow period. Pressure-drop variation should not exceed 5% of initial value.



BUBBLE TEST determines where the greatest porosity of the filter element lies. Bubble pressure test values must fall between minimum and maximum limits to indicate adequate porosity of the filter element. Limits are to be established prior to actual testing of filter element. Air pressure within element should be raised in small increments while element is rotated 360 deg at each increment. Fluid used shall be Solox 190 or its equivalent.



PRESSURE BUILDUP AND BURST-PRESSURE TEST—measures buildup and collapse pressure characteristics. Pre-cleaning of test fluid is required. Sample line element is installed in housing, pump started, valves A and B opened, and rated flow attained by adjusting vari-drive. AC dust is added through dust valve H. Temperature is raised to 275 F, and collapse pressure of element determined by adding additional quantities of AC dust.

Filter Spec Will Improve Missile Hydraulic Systems

testing 15-micron filters. Results of the degree-of-filtration efficiency test and the largest-particle test are more accurate and repeatable than tests prescribed in MIL-F-5504 calling for standard AC fine dust. (See Degree-of-Filtration Test.)

The bubble test is another feature of the 15-micron filter specification. Results can be easily correlated with the largest-particle test data obtained with the glass beads. (See Bubble Test.)

A pressure buildup and burst-pressure test calls for a temperature rise to 275 F. The collapse pressure of the element is determined by adding additional quantities of AC dust to the test system. (See Pressure Buildup and Burst-Pressure Test.)

A media migration test is specified, though it is not required in MIL-F-5504. The test insures that the filter element will not contribute to fluid contamination by flaking, shedding, or other deterioration.

Included among the performance tests are a proof-pressure test, housing-pressure drop test, room-temperature system test, extreme-temperature test, impulse test, burst-pressure test, room-temperature flow-rate test, 275 F flow test, flow-fatigue test, and permanence of bonding test.

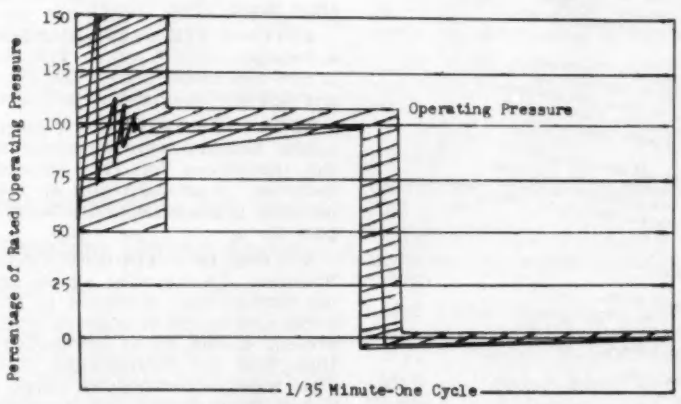
Proposed design calls for a wire mesh filter, which may or may not be made of sintered metal. Media of fiber-phenolic and sintered-bronze or stainless-steel particles will probably not be satisfactory for 15-micron filters.

Brazing techniques for bonding screen to end caps are presented.

Except for the completely new "popup" indicator specified to fit into the smallest envelopes, no new operating principles are involved.

Qualification tests specified for the absolute 15-micron filter are expected to form the basis of future filter specifications where still finer filtration and higher temperatures are required.

J. Milton Kidd of the Martin Co. is chairman of the Filter Panel which developed the new filter specification. Those who assisted in the development of the specification are: E. Gravenhorst, Martin Co.; R. G. Barnes, Jr., Cuno Engineering Corp.; Charles Casaleggi, Purolator Products, Inc.; W. N. Caldwell, Poroloy Equipment, Inc.; J. J. Duzich, Fram Corp.; J. A. Farris, Aircraft Porous Media, Inc.; H. L. Forman, Purolator Products; R. I. Gross, Aircraft Porous Media; Walter Kasten, Skinner Division of Bendix Aviation; George Keller, Autonetics Division, North American Aviation; John McKee, Fram Corp.; D. B. Pall, Aircraft Porous Media, Inc.; F. H. Pollard, Republic Aviation.



APPROXIMATE PRESSURE-TIME CYCLE determined to be of proper severity for impulse testing is shown above. Peak pressure must rise to 150% of operating pressure prior to leveling off at rated pressure. Pressure-time curve should be confined to shaded area.

CRC Recommends L-38 Technique Over L-4

REPLACEMENT of the L-4 oil testing technique by the L-38 technique is advised in CRC report 306, "Development of Research Technique for Study of the Oxidation Characteristics of Crankcase Oils in the CLR Oil Test Engine." A reference oil and a commercial oil were studied using L-38 and L-4 techniques. Results were correlated and information developed which had a bearing on the acceptability of the L-38 technique versus the L-4 technique.

A summary of the results follows:

- CRC Designation L-38-357 is considered suitable for discriminating between oils with respect to copper-lead bearing corrosion on a 'go' or a 'no go' basis.
- Reproducibility of bearing corrosion results obtained using the L-38 technique appears as good as that for the L-4 technique, although the reproducibility of both techniques is poor.
- The bearing-corrosion repeatability of the L-38 technique appears as good as that secured using the L-4 technique.
- The spread in bearing-corrosion results between REO-7 and the blend of 55% REO-7 and 45% REO-12 varies widely among laboratories with both the L-38 and L-4 techniques.
- The bearing-corrosion level obtained, for the oils tested, is generally lower with the L-38 technique than with the L-4 technique.
- The L-38 technique discriminates between the varnish and sludge-formation characteristics as does the L-4 technique. Indications are that the L-38 technique is slightly more severe on varnish formation and slightly less severe on sludge formation than is the L-4 technique.
- Oil oxidation, on the basis of viscosity increase, using the L-38 technique is approximately half that obtained using the L-4 technique, although both techniques rate the oxidation characteristics of the oils tested in the same relative order.
- The available data indicate that the reproducibility of oil oxidation using the L-38 technique, like the L-4 technique, is poor.

Additional cooperative work is recommended for the L-38 technique to improve its repeatability and reproducibility. A better measure of oil discrimination is also recommended for use with the L-38 technique.

CRC report 306 contains 110 pages including tables, figures, and appendixes.

To Order Paper No. 306 . . .
on which this article is based, see p. 5

President Eddy Salutes Technical Advances of 1957 SAE Handbook

IN support of technological progress, 2000 SAE technical committee members produced 17 new and 79 revised reports for inclusion in the 1957 Handbook. Here is a thumbnail description of a few Technical-Board-approved reports appearing in the 43rd edition of the SAE Handbook.

New Reports

TITANIUM AND TITANIUM ALLOYS, a General Information Report, is the first material on titanium to appear in the Handbook. It describes titanium sources, physical properties, commercially pure titanium, all-alpha and alpha-beta weldable alloys, and alpha-beta nonweldable alloys. Tables are included on nominal chemical composition, physical properties of annealed titanium, available forms, and highest temperature recommended for 1000 hr service.

MEASUREMENT OF TRUCK AND BUS NOISE, a Recommended Practice, prescribes equipment and procedures for the scientific measurement of truck noise loudness. The report was adopted from information previously established by the SAE, AMA, and ATA.

AUTOMOTIVE NODULAR CAST IRONS, a Recommended Practice, covers specifications for nodular (ductile or spheroidal graphite) iron castings for motor vehicles, agricultural equipment, and general machinery. Processes for making the irons, workmanship, machinability, physical properties, and grading are included.

TRUCK-TRAILER, AND MOTOR COACH WIRING, a Recommended Practice, was developed for the guidance of body builders and body repair services to promote good lighting on commercial vehicles.

PREFERRED DRIVE WHEEL TIRE AND RIM SIZES FOR GENERAL-PURPOSE FARM TRACTORS, a Recommended Practice, establishes a series of tire and rim sizes for farm tractors in several groups. Each group has one or more tire sections with a substantially common rolling radius and outside diameter.

HYDRAULIC EQUIPMENT TEST CODE, a Recommended Practice, applies to hydraulic directional control valves used primarily in industrial and construction equipment.

SOCIETY OF AUTOMOTIVE ENGINEERS
INC.
485 LEXINGTON AVENUE
NEW YORK 17, N.Y.

East Hartford
Connecticut
August 6, 1957

Mr. A. E. W. Johnson
Chairman, SAE Technical Board
C/o International Harvester Co., Inc.
180 North Michigan Avenue
Chicago 1, Illinois

Dear Arnold:

When one stops to think of what lies behind the release of the 1957 SAE Handbook, one suddenly realizes its amazing value in terms of what cooperative engineering, at its best, can be.

The 1957 Handbook is a credit to the Technical Board and to the thousands of engineers who serve on SAE technical committees. It is a tribute not only to those who are currently engaged in committee projects, but to those who have contributed their time and talents in years past.

Industry, the Society, and the public are greatly indebted to these men for benefits derived from the use of technical committee reports. These benefits are reflected in dollar savings, as well as in greater safety and comfort in transportation.

Congratulations on a job well done.

Sincerely yours,

W. Paul Eddy

W. Paul Eddy
President

WPE:A

Revised Reports

PISTON RINGS AND PISTONS, a Standard—Range of ring widths in the smaller sizes was increased to reflect present practices in the automotive industry for bore diameters 4 in. and over.

INVOLUTE SPLINES, SERRATIONS, AND INSPECTION, a Standard—A major undertaking, the revision of this report represents the consolidation of information previously contained in reports on Involute Splines, Involute Serrations, and Involute Spline and Serration Gages and Gaging. The method of selecting a spline has been simplified and the parts standard integrated with gaging requirements.

MOTOR-VEHICLE SEAT BELT ASSEMBLIES, a Recommended Practice—Revisions substantially alter the test procedures for determining whether the belt assembly meets the minimum strength criteria, but do not change basic minimum strength requirements. The revised test procedure provides for making the tensile test of the belt assembly over a body block, eliminating the former straightening tension test.

HYDRAULIC-BRAKE FLUID (70R), A Standard — Moderate-Duty Brake Fluid (70R2) was deleted as the result of field tests made on minimum safe boiling points. Work is underway to develop a standard for a Truck Heavy-Duty Brake Fluid (70R3).

AUTOMOTIVE STEEL CASTINGS, a Recommended Practice—This report is now applicable to both the automotive and the steel casting industries.

STORAGE BATTERIES, a Standard—New batteries were incorporated in the tabulations for 12-v automotive batteries. A special report on testing batteries is available as Technical Report 33.

AUTOMOTIVE TUBE FITTINGS, a Standard — Automotive air-conditioning fittings were developed to fit between and be interchangeable with the present 45-deg flared automotive fittings and the refrigeration fittings. This series accommodates single and double flared tubing and incorporates weight savings in the fittings.

4-LAMP HEADLAMP SYSTEMS—Performance requirement for the new 4-lamp headlamp systems were incorporated in applicable lighting standards.

Multipurpose Greases Evaluated by CRC

THE effect of multipurpose greases on performance of automotive components is presented in CRC report 307, "Development of Field Testing of Global Greases, 1948-1954." Requested by the Ordnance Corps, a series of field tests were conducted which required the use of 'global' greases. Detailed observations on the results of each test series are recorded in the report.

In 1948, six global greases were selected by the CRC Grease Advisory Group for use in 12 trucks weighing 2½ tons or under. Greases used for 30,000 test miles were RLG-163, RLG-165, RLG 167, RLG-169, RLG-170, and RLG-174. Climatic conditions ranged from Alaskan winters to Californian summers in the desert.

In 1952, both the Southwest Research Institute (SRI) and Ordnance Climatic Test Station (OCTS) ran tests on 12 trucks weighing ¾-, 2½-, or 5-tons. Greased with RLG-189, RLG-190, RLG-191, and RLG-192, the trucks were run 30,000 miles by the SRI in tests which took place in San Antonio, Texas. Subsequently, OCTS used greases RLG-201, RLG-202, and RLG-203 for 10,000 miles of testing in Death Valley, Arizona. Elevations ranged from sea level to 5000 ft.

In 1953, the SRI and OCTS used the same 12 trucks tested in 1952. In San Antonio, SRI tests were conducted for a total of 20,000 miles using RLG-206, RLG-207, RLG-208, RLG-209, and a blend of the last two. In Yuma, Arizona, OCTS tests covered approximately 12,000 miles in 15 standard Ordnance wheeled transport vehicles.

In 1954, the OCTS tested 15 vehicles operated for a total of 10,000 miles in Yuma. Two production greases conforming to MIL-G-10924, Amendment 2 Specification, were tested.

CRC 307 which contains 33 pages including appendixes.

To Order CRC report 307 . . . on which this article is based, see p. 5

New Procedure Set for Estimating Octane Curve

A NEW procedure for estimating the octane requirement distribution curve of an entire car population from information obtained on a small sample is presented in CRC report 305, "A New Procedure for Plotting Octane Number Requirement Distribution Data."

The new procedure gives a slightly higher octane number requirement distribution curve than the previous procedure. It also constitutes an improvement over the previous procedure since the distribution curve for the small sample generally lies closer to the curve for the total population than does a similar curve drawn according to the previous procedure.

The new procedure calls for listing the test cars in order of ascending octane requirements. An i number is assigned for each car up to the total number of cars N(i = 1, 2, 3, . . . N). For each i, the per cent of cars satisfied is calculated from:

$$\text{per cent} = \frac{i}{N+1} \times 100$$

Finally, the octane requirement for each car is plotted against the above percentage calculated for its i number. The use of arithmetic probability paper is recommended.

CRC 305 contains 35 pages including tables and graphs.

To Order CRC report 305 . . . on which this article is based, see p. 5

Technishorts . . .

PACKING OF BALL JOINT BEARINGS is the subject of a proposed SAE report being prepared jointly by the National Lubricating Grease Institute and Subcommittee C—Chassis Lubricants of SAE Fuels and Lubricants Technical Committee. All types of ball joint bearings now in use, plus any new type which may be introduced in the future, will be considered. In addition, Subcommittee C is reviewing chassis lubricants as referenced in the SAE Handbook.

SAE AUTOMOTIVE DRAFTING STANDARDS—A revision of this publication is expected to be available in January 1958. Meanwhile, purchasers are being advised of the impending revision with the suggestion that their orders be placed soon.

21 New, 4 Revised AMSs Released By SAE

21 new and 4 revised Aeronautical Materials Specifications have been released by the Society. They were issued September 15 and may be obtained as a set or individually.

- AMS 2404—Electroless Nickel Plating
- AMS 2476—Electrolytic Treatment for Magnesium Base Alloys, Alkaline Type—Full Coat
- AMS 2478—Electrolytic Treatment for Magnesium Base Alloys, Acid Type—Full Coat
- AMS 4054—Aluminum Alloy Sheet, Aluminum Alloy Clad, 0.6Mg-0.35Si-0.3Cu (No. 21 Brazing Sheet)
- AMS 4055—Aluminum Alloy Sheet, Aluminum Alloy Clad, 0.6Mg-0.35Si-0.3Cu (No. 22 Brazing Sheet)
- AMS 4227—Aluminum Alloy Castings, Sand, 8Cu-6Mg-0.5Mn-0.5Ni (XA-140F)
- AMS 4384—Magnesium Alloy Sheet, HK31A-0
- AMS 4385—Magnesium Alloy Sheet, HK31A-H24
- AMS 5353—Steel Castings, Precision Investment, Corrosion Resistant, 16Cr-1.85Ni
- AMS 5529A—Steel Sheet and Strip, Corrosion Resistant, 17Cr-7Ni-1Al Precipitation Hardening—200,000 psi
- AMS 5547—Steel Sheet and Strip, Corrosion and Moderate Heat Resistant, 15.5Cr-4.5Ni-2.9Mo-0.1N
- AMS 5554—Steel Tubing, Seamless, Corrosion and Moderate Heat Resistant, 16.5Cr-4.5Ni-2.9Mo-0.1N
- AMS 5643D—Steel, Corrosion Resistant, 17Cr-4Ni-4Cu
- AMS 5698A—Alloy Wire, Corrosion and Heat Resistant, Nickel Base—15.5Cr-7Fe-2.3Ti-1(Cb + Ta)-0.7Al, No. 1 Temper
- AMS 5699A—Alloy Wire, Corrosion and Heat Resistant, Nickel Base—15.5Cr - 7Fe - 2.3Ti - 1(Cb + Ta) - 0.7Al, Spring Temper
- AMS 5743—Steel, Corrosion and Moderate Heat Resistant, 15.5Cr-4.5Ni-2.9Mo-0.1N
- AMS 5780—Steel Wire, Corrosion and Moderate Heat Resistant, 15.5Cr-4.5Ni-2.9Mo-0.1N
- AMS 5781 — Welding Electrodes, Coated, Steel, Corrosion and Moderate Heat Resistant, 15.5Cr-4.5Ni-2.9Mo-0.1N
- AMS 7455—Bolts and Screws, Steel, Low Alloy Heat Resistant, Hardened and Tempered—Roll Threaded.
- AMS 7706—Iron, Commercially Pure, Hot Rolled, Annealed
- AMS 7707—Iron, Commercially Pure, Hot Rolled, Unannealed
- AMS 7711—Steel, Flat-Rolled Electrical, 1.5Si, AISI Type M-36, Semiprocessed
- AMS 7712—Steel, Flat-Rolled Electrical, 2.5Si, AISI Type M-27, Semiprocessed
- AMS 7714—Steel, Flat-Rolled Electrical, 3Si, AISI Type M-19, Semiprocessed
- AMS 7715—Steel, Flat-Rolled Electrical, 4.25Si, AISI Type M-15, Semiprocessed

The above may be obtained by request to SAE Headquarters. The entire set is available for $3.50 including a revised AMS Index. If ordered individually, the specifications are $0.17 each.

the S.A.E. STORY for October

RIBLET

KITSON

Co-Authors Chosen for L. Ray Buckendale Award

ROBERT M. Riblet and Charles M. Kitson, both of the Timken Roller Bearing Co., have been selected to present the 1957 SAE L. Ray Buckendale Lecture and receive the fourth annual L. Ray Buckendale Award. The lecture and presentation will be made during the week of November 3, at the time of the SAE National Transportation, Diesel-Engine, Fuels and Lubricants Meettings in Cleveland.

The Buckendale Lecture is presented annually in honor of the late L. Ray Buckendale, SAE president for 1946 and vice-president in charge of engineering, the Timken-Detroit Axle Co. A cash prize and certificate are awarded for a lecture and monograph by a distinguished authority, or authorities, in the technical areas of commercial or military ground vehicles. The lectures are directed toward filling the needs of young engineers and students for up-to-date practical knowledge.

Riblet and co-author Kitson have selected "Bearing Applications for Heavy-Duty Axles" for their lecture topic. The authors will present a practical discussion of the application of tapered roller bearings to heavy-duty axles, with emphasis on bearing selection, mounting, adjustment, and lubrication. The lecture defines heavy-duty axles and their function and the basic types of antifriction bearings. The paper includes a discussion of tapered roller bearing design, nomenclature, and basic ratings. Numerous typical bearing applications in wheels and axle centers are illustrated and covered. Calculations for selecting bearings for a typical heavy-duty front axle and a hypoid rear axle center are shown in detail. The lecture will emphasize the effect of bearing alignment and machining practice on bearing life and proper bearing fitting with recommended fits.

Robert M. Riblet started with the Timken Roller Bearing Co. as a draftsman in 1912. He served in different engineering divisions of the company and, in 1934, was made assistant chief engineer of the Automotive Division. Riblet became chief engineer of the division in 1938, the position he holds at present. He has been active in SAE since 1925 and has served as vice-chairman of the Cleveland Section and is a member of the Ball and Roller Bearings Committee.

Charles M. Kitson, assistant chief engineer, Automotive Division, the Timken Roller Bearing Co., has been a member of SAE since 1946. He received a Bachelor of Mechanical Engineering degree in 1930 from Ohio State University. Kitson has been associated with Timken since 1928, serving in the tool design, bearing design, and automotive engineering departments and physical laboratory before assuming his present position. Kitson is vice-chairman of the Akron-Canton District of the SAE Cleveland Section for '57–'58.

Ernest P. Lamb, chairman of the Buckendale Lecture Committee, will make the award presentation at the time of the lecture, Tuesday evening, November 5, at a session sponsored by the SAE Cleveland Section.

SAE Preprints Now Priced at 50 cts.

THE price of "preprints" of papers presented at SAE meetings will be 50¢ to members (and 75¢ to nonmembers) beginning October 15, 1957. SAE Council authorized the change at its September 15 meeting in Milwaukee.

At the same time, the price was changed for the coupon books which have become popular for use in buying SAE papers and Special Publications. Each book, priced at $9, will contain 20 coupons worth 50¢ each. Purchase of a coupon book, in other words, will permit the purchase of $10 worth of papers and SAE Special Publications for $9.

You'll . . .

be interested to know . . .

The terms of the following SAE-Nominated Directors on the Coordinating Research Council, Inc., will expire Dec. 31, 1957: **E. N. COLE, ARTHUR NUTT, G. L. HUEBNER, JR.,** and **F. W. FINK.** Under the By-Laws of CRC, Directors may be named to succeed themselves.

SAE-Nominated Directors for a two-year term, beginning in January, 1958, are: **ARTHUR NUTT, G. J. HUEBNER, JR., F. W. FINK,** and **H. F. BARR.** Barr is the only new appointment, the other members have been nominated to succeed themselves. Harry F. Barr is chief engineer, Chevrolet Motor Division, General Motors Corp.

SAE members on the CRC Board who still have one year to serve are: **R. F. KOHR, M. R. BENNETT,** and **D. D. STREID.**

FINGER

Messrs. Finger and Benser Selected for Manly Memorial Award

• Paper entitled "Compressor-Stall Problems in Gas-Turbine Aircraft Engines"

BENSER

HAROLD B. Finger and William A. Benser, both of Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, have been selected to receive the 1956 Manly Memorial Medal. The presentation will be made at a luncheon, October 2, at the SAE National Aeronautical Meeting in Los Angeles.

The Manly Award is given annually to the author, or authors, of the "best paper relating to theory or practice in the design or construction of, or research on, aeronautical powerplants or their parts or accessories which shall have been made at a meeting of SAE." Finger and Benser's paper entitled "Compressor-Stall Problems in Gas-Turbine Type Aircraft Engines" was presented at the SAE National Aeronautical Meeting in New York, April, 1956.

Harold B. Finger was graduated from the City College of New York, and received a Master of Science degree in Aeronautical Engineering from Case Institute of Technology in 1950. He has been employed at the Lewis Flight Propulsion Laboratory of NACA, Cleveland, since 1944. Finger's work at NACA has been primarily in the field of research on compressors and also on turbines intended for aircraft application. He is the author of many NACA and society papers on the subject. In 1951 he became head of the axial-flow compressor section and in 1956 he was named associate chief of the compressor research branch at the Lewis Laboratory. He is at the present time engaged in work regarding the application of nuclear energy to flight powerplants.

William A. Benser received a Bachelor of Science degree in Mechanical Engineering in 1942 from Iowa State College. In June of 1942 he became affiliated with the Langley Aeronautical Laboratory of NACA and in 1943 was transferred to the Lewis Flight Propulsion Laboratory of NACA. For the first four years of his employment at the NACA he did research work on superchargers and induction systems for reciprocating engines. For the past 11 years he has been engaged in research on compressors and turbines for aircraft gas turbine types of engines. He was a section head from 1946 to 1950 and a branch chief from 1950 to date. He currently is chief of the compressor and turbine branch of the Propulsion Systems Division of the Lewis Laboratory.

The Manly Memorial Medal will be presented on behalf of SAE by Kenneth Campbell, chairman of the Manly Memorial Board of Award.

John Malcolm Campbell To Present Annual Horning Memorial Lecture

JOHN Malcolm Campbell, scientific director of the Research Staff of General Motors Corp., has been selected to present the SAE Horning Memorial Lecture and receive the 1956 Horning Memorial Award on Nov. 7, 1957, during the SAE National Fuels and Lubricants Meeting in Cleveland, Ohio. The lecture, entitled "Looking Ahead in Fuels for Automotive Transportation," and presentation will be given at a Horning Memorial Luncheon at the Statler Hotel in Cleveland.

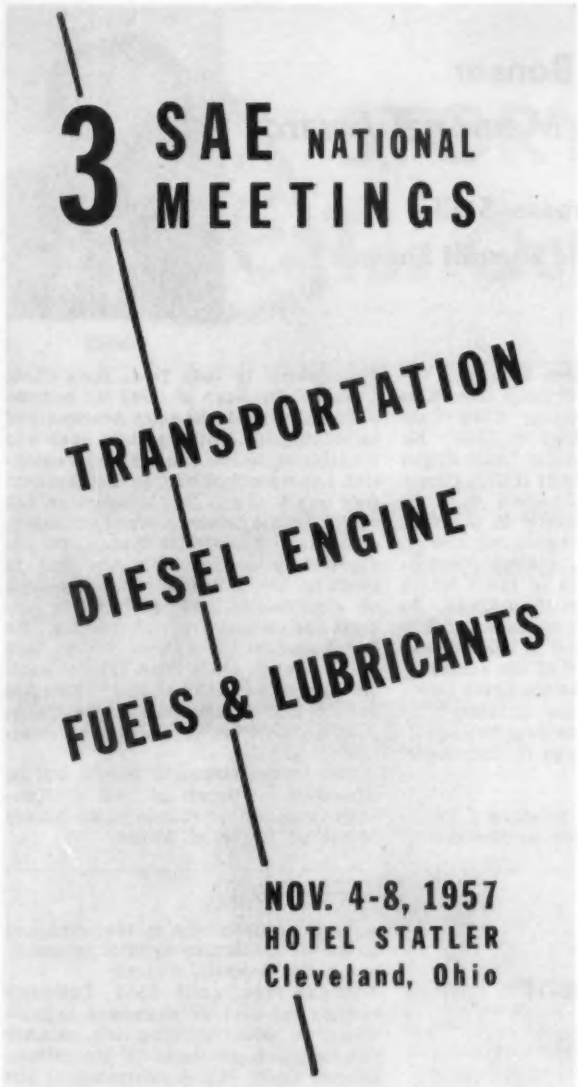
In arriving at the Award decision, the Horning Memorial Award Board selected Campbell "in recognition of distinguished active service in the field of mutual adaptation of fuels and engines."

John M. Campbell was graduated from Massachusetts Institute of Technology in 1925 and joined the General Motors Research Laboratories Division in 1926. In 1942 he transferred to the GM Proving Ground, concentrating on military projects and in 1944 returned to the Research Laboratories as assistant to the technical director.

From 1947 until 1952 Campbell headed the organic chemistry department, his work resulting in a number of patents on processes for the utilization of fuels. Upon returning to the Research Staff (formerly the Research Laboratories Division), Campbell served as assistant technical director, administrative director, and subsequently technical director. In 1957 he was named scientific director and principal assistant to the GM vice-president, Research Staff.

Campbell is past SAE vice-president representing Fuels and Lubricants and has served for many years with the Coordinating Research Council as a member of the War Advisory Committee and chairman of the Motor Fuels Division. Currently he is a director of the ASTM.

The Horning Award was established in 1936 in memory of SAE Past-President Harry L. Horning, a leader in the standardization of testing fuels and the mutual adaptation of fuels and engines. H. W. Best, chairman of the Horning Memorial Board of Award, and Mrs. Harry L. Horning, sponsor, will make the presentation jointly.



Transportation Meeting

November 4-6

- Problems of Design and Maintenance of Light Vehicles (Panel)
- Turbocharged Diesels
- Air Suspension Gives Flexible Truck Design
- Training for Maintenance
- Oils and Icing
- Truck Power Take-Off Drive Applications (Panel)

★ ★ ★

Diesel Engine Meeting

November 5-6

- Railroad Diesel
- Two-Cycle Diesels
- Fuel Systems and Heat Transfer
- Rating Diesel Lubricants

★ ★ ★

Fuels and Lubricants Meeting

November 7-8

- Lubricants (All Day Session)
- Fuels for High-Compression Engines
- Road and Laboratory Antiknock (Symposium)

Joint Dinner

Wednesday, November 6
Grand Ballroom

"The Highway for the Future"

Louis B. Seltzer
Editor in Chief, Scripps-Howard Ohio Newspapers, and Editor, Cleveland Press

Special Events

Monday, November 4

Visit to Thompson Products Auto Album and Aviation Museum

E. K. Brown, Chairman

L. Ray Buckendale Award

Tuesday, November 5

L. Ray Buckendale Lecture

"Bearing Application for Heavy-Duty Axles"

R. M. Riblet and C. M. Kitson

The Timken Roller Bearing Co.
To be presented by Mr. Kitson

Horning Memorial Luncheon

Thursday, November 7

Horning Memorial Lecture

"Looking Ahead in Fuels for Automotive Transportation"

John M. Campbell

Scientific Director of Research Staff, General Motors Corp.

Plant Visits

November 4-7

- Euclid Division, GMC.
- Ford Motor Co., Engine and Foundry Plants
- Cleveland Diesel Division, GMC.
- Lubrizol Corp.
- Chevrolet Division, GMC.
- Standard Oil Co. (Ohio), Refinery and Auto Laboratory
- Valve Division, Thompson Products, Inc.
- Lewis Flight Propulsion Laboratory, NACA
- White Motor Co.

SAE National Meetings

1957

November 4-6
Transportation Meeting, Hotel Statler, Cleveland, Ohio

November 5-6
Diesel Engine Meeting, Hotel Statler, Cleveland, Ohio

November 6-8
Fuels and Lubricants Meeting, Hotel Statler, Cleveland, Ohio

1958

January 13-17
Annual Meeting and Engineering Display, The Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

March 4-6
Passenger Car, Body and Materials Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

March 31-April 2
Production Meeting and Forum, The Drake, Chicago, Ill.

April 8-11
Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display, Hotel Commodore, N. Y., N. Y.

June 8-13
Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

August 11-14
West Coast Meeting, Ambassador, Los Angeles, Calif.

September 8-11
Farm, Construction and Industrial Machinery, Production Forum, and Engineering Display, Milwaukee Auditorium, Milwaukee, Wis.

September 29-October 3
Aeronautic Meeting, Aircraft Production Forum, and Engineering Display, Ambassador, Los Angeles, Calif.

October 20-22
Transportation Meeting, Lord Baltimore Hotel, Baltimore, Md.

October 22-24
Diesel Engine Meeting, Lord Baltimore Hotel, Baltimore, Md.

November 5-6
Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

Are You A Consultant ? ? ?

SAE Placement Service has announced a NEW service designed specifically for members engaged in consultant work—either full or part time—now working or retired.

The plan is to mail an SAE CONSULTANTS list to several hundred employers who now use the Placement Service. Specific inquiries for consultants will also be answered by the SAE Placement Service.

To make known his availability as a consultant, an SAE member needs only to fill out the brief form shown below, and mail it to SAE Placement Service, 485 Lexington Avenue, New York 17, N. Y.

Forms may be obtained from Section Placement chairmen or directly from SAE Placement Service in New York.

The first SAE Consultants list, scheduled for mailing after Jan. 1, 1958, will contain all names and information received on the form.

Subsequently, this list will be published yearly. Its format will be similar to the familiar SAE Men Available Bulletin except that the consultants listing will not be coded. Names and addresses will be given so that companies may contact consultants directly. The list will be broken down into geographical locations.

Type or print information as you wish it to appear on SAE CONSULTANTS list.

Specialty	Geographical Preference	Background
		Name Address Telephone

Sperry Board of Award Selects Contributors to a Complex Project

HAMILTON

DILWORTH

KETTERING

"FOR developing the diesel-electric locomotive which helped revolutionize American railroading," three of the early engineering and managerial personnel of the Electro-Motive Division of General Motors Corp. and four sections of the corporation will receive the 1957 Elmer A. Sperry Award. Robert B. Lea, chairman of the Sperry Board of Award, pointed out that, for the first time, a major engineering award will go not to one person but to a number of individuals and groups for contributions to a complex project.

The award recognizes "a distinguished engineering contribution which, through application, proved in actual service, has advanced the art of transportation whether by land, sea, or air." The presentation is made on behalf of four sponsoring engineering societies, the Society of Automotive Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers. Formal presentation will take place during the 1957 Fall General Meeting of the American Institute of Electrical Engineers at a special luncheon at the Morrison Hotel in Chicago, October 10.

The three leaders who are to share the award are Harold L. Hamilton, Richard M. Dilworth, and Eugene W. Kettering. The four sections of the engineering department of Electro-Motive cited for having made major contributions to the achievement are the controls section, electrical engineering section, locomotive section, and mechanical engineering section.

Harold L. Hamilton, a retired vice-president of GMC and founder of Electro-Motive, was the leader during the entire period of development until the GMC diesel-electric locomotive was accepted in all branches of United States railroad service in 1940.

Richard M. Dilworth, retired, was chief engineer of Electro-Motive from 1926 to 1951 and, as such, headed the research and design work resulting in the first successful application of the diesel-electric as a prime mover for the propulsion of trains of all classes.

Eugene W. Kettering, now director of research, Electro-Motive Division, GMC, was in direct charge of the development of the GM 567 series diesel engine from 1936 to 1942. This unit was the major element in broadening the capability of the diesel-electric locomotive to cover all phases of domestic railroad motive-power needs.

"It should be explained," said Mr. Lea, "that in making this award the board took into account the fact that the period of development extended from the establishment of the definite concept of the diesel-electric locomotive in the early thirties through 1940 when the work on the locomotive had progressed to the point where it was released for quality production and numerous orders had been received from operating railroads. That marked, in our opinion, the point at which it might accurately be said that the diesel-electric locomotive had arrived. The three men designated to receive the award for 1957 were major figures in the development to that point."

The Sperry Award commemorates the life and achievements of the late Dr. Elmer A. Sperry, whose wide range of inventions and more than 400 patents included coal-mining machines, electric vehicles, high-intensity lights, industrial processes, and numerous gyroscopic devices now used on ships and aircraft. The award has been established by Dr. Sperry's daughter, Mrs. Robert Brook Lea, and his son, Elmer, Jr.

SECTIONS

OCTOBER, 1957

Field Editors 1957-58 . . .

ATLANTA . . .
J. F. Collins, Jr.

BALTIMORE . . .
Dale E. Woomert

BUFFALO . . .
Clifford Lane

CANADIAN . . .
Frank G. King

CENTRAL ILLINOIS . . .
Roy D. Chandler

CHICAGO . . .
Ivan R. Dawson

CINCINNATI . . .
William Gordon

CLEVELAND . . .
W. B. Fiske

DAYTON . . .
Robert E. Antheil

DETROIT . . .
William F. Sherman

HAWAII . . .
Clifford Geis

INDIANA . . .
B. A. Woodhull

KANSAS CITY . . .
Carroll Abrams

METROPOLITAN . . .
H. S. Gerstung
Henry H. Wakeland

MID-CONTINENT . . .
Howe M. Carey

MID-MICHIGAN . . .
William H. Lichty

MILWAUKEE . . .
D. M. McDowell

MOHAWK-HUDSON . . .
John H. DeWitt

MONTREAL . . .
Alban A. Larkin

NEW ENGLAND . . .
Asa E. Snyder

NO. CALIFORNIA . . .
R. D. Lint

NORTHWEST . . .
Merl Earnhart

PHILADELPHIA . . .
Joseph A. Daley

PITTSBURGH . . .
M. J. Boegel

SALT LAKE GROUP . . .
Bill Littreal

SAN DIEGO . . .
Elmer H. Cooke

SO. TEXAS GROUP . . .
Robert E. Engelhardt

SO. CALIFORNIA . . .
W. E. Achor
J. F. Harrington

SO. NEW ENGLAND . . .
Ross S. Karlson

ST. LOUIS . . .
H. S. Gershenson

SYRACUSE . . .
Preston Billings

TEXAS . . .
Charles Cates

TEXAS GULF COAST . . .
F. A. Landers

TWIN CITY . . .
R. A. Hill

VIRGINIA . . .
Douglas V. Bralley

WASHINGTON . . .
Paul R. Churan

WESTERN MICHIGAN . . .
Donald A. Paull

WICHITA . . .
Herman D. Barnett

WILLIAMSPORT GROUP . . .
B. L. Sharon

Pittsburgh Section Presents . . .

"YOUR AUTO & YOU"

Metropolitan Pittsburgh WQED-TV
Channel 13

Fridays—7:30-8:00 p.m.

October
November
December

A Certificate of Appreciation was awarded to 1956–57 Chairman **CHARLES E. CHAMBERLISS** (right) by members of the SAE Metropolitan Section Governing Board. Past Chairman **NEIL FLYNN** (left) made the presentation at the Metropolitan Section Spring Dinner Dance.

About SAE


Kyropoulos


Barrett


Spicer


Thornburgh


Scanlan


Taylor


Davidson


Wintringham


Huester


Martin

DR. PETER KYROPOULOS has been made executive in charge of Technical Development of General Motors Styling, General Motors Corp. In his new position he will supervise technical aspects of advance planning and will also do liaison work for styling with colleges and professional groups.

Kyropouluos has been an Associate Professor of Mechanical Engineering at California Institute of Technology since 1941. He has worked summers since 1953 as a consultant for the General Motors Research Staff and was active in the development of both Firebird I and Firebird II, GM's gas turbine cars. He conducted the aerodynamic testing of Firebird I in the Guggenheim Wind Tunnel at California Institute of Technology.

JAMES J. BARRETT has been appointed manager of extrusion sales for the Tubular Products Division, Babcock & Wilcox Co. In his new post, Barrett will direct the sales of hollow and solid extrusions. Formerly he had been sales manager of the Gemmer Mfg. Co. of Detroit.

DONALD H. SPICER has joined the Ferry Cap and Set Screw Co., Cleveland, Ohio, as vice-president, industrial sales. Formerly he has served as vice-president of sales of the Morse Chain Co., Ithaca, N. Y., and vice-president of sales of the American Bosch Co., and president of the World Bestos Corp. in New Castle, Md.

J. W. THORNBURGH has been named sales engineer in the Universal Joint Division of the Dana Corp.'s sales department in Toledo, Ohio. Thornburgh joined Dana in 1947 as a draftsman.

J. A. SCANLAN, assistant professor of mechanical engineering and SAE student advisor at the University of Texas, was recently awarded a Ph.D. degree by Northwestern University. His dissertation concerned the effects of vibration on heat transfer.

In addition to his teaching and counseling duties, Scanlan is currently engaged in furthering heat transfer research, and in broadening the university's program of obtaining an operating nuclear reactor specifically designed for educational and training purposes.

SYDNEY W. TAYLOR, formerly vice-president in charge of engineering of Willys Motors, Inc., has been elected a vice-president of Willys-Overland Export Corp. He also will serve as chief engineer of the export subsidiary and continue as vice-president of the parent company.

JAMES R. DAVIDSON has been appointed vice-president and general sales manager of Capac Industries, Inc., Capac, Mich. Formerly, for 11 years, he was with Hoosier Cardinal Corp. where he had served as sales manager for the Plastics Division.

JOHN S. WINTRINGHAM has been named to the newly created position of senior research advisor at the Ethyl Corp. Research Laboratories in Detroit. He joined Ethyl in 1930 following graduation from Harvard University as a mechanical engineer, and has held several supervisory and engineering positions in the company's research organization.

CMDR. H. J. HUESTER, USNR, a 25 year member of SAE and ardent worker in various engineering societies, has been transferred from the Naval Air Station, Jacksonville, Fla., Aeronautical Engineering—O&R Department.

His new post is Deputy Director of the Aeronautical Structures Laboratory, NAMATCEN, Philadelphia. This activity was formerly the Naval Aircraft Factory which was the first in Naval aviation, research, and development. Huester had his initial start at the Naval Aircraft Factory in 1918, and has been connected with Naval aviation over this period.

CHARLES E. MARTIN has been appointed general service manager and member of the executive committee of the Cummins Engine Co., Inc. of Columbus, Ind. He joined the Cummins Co. in 1943 and has been employed in the sales and service divisions of the company. Prior to his new appointment, he was manager—Field Service for the company.

FRANK I. GOODRICH has been elected vice-president-administrative of Eaton Mfg. Co. Prior to his election, Goodrich was staff assistant to the vice-president-administrative. In his new post, Goodrich will direct the activities of all Michigan plants.

F. H. MOTT has retired from his position as vice-president-administrative, in charge of all Eaton's Michigan plants. He has been with the company for 38 years.

Mott joined the company in 1919 in the accounting department of Rich Steel Products Co., one of Eaton's predecessor companies. In 1954 he was appointed director.

STEPHEN JOHNSON, JR. has been appointed general manager of the air brake division of Bendix-Westinghouse Automotive Air Brake Co., Elyria, Ohio. He has served successively as general engineer, superintendent of manufacturing, manager of sales engineering, assistant sales manager, chief engineer and, since 1956, director of engineering.

R. VAN DYKE FIRTH has been made director of engineering, Air Brake Division, Bendix-Westinghouse Automotive Air Brake Co. Firth joined Bendix-Westinghouse in 1948 as project engineer, became research engineer in 1950, executive engineer in 1955, and chief engineer in 1956.

HARRY M. VALENTINE has been made chief engineer at the Air Brake Division, Bendix-Westinghouse Automotive Air Brake Co. He joined the company in 1940 as a draftsman and later became mechanical designer. He was made assistant to the design engineer in charge of new development in

Members

Goodrich

Mott

Johnson

Firth

Valentine

Cormany

Rowley

McClure

Chilton

Collins

1953, and one year later was appointed head of that department.

GEORGE E. TERNENT has been made new product design engineer, Air Brake Division, Bendix-Westinghouse Automotive Air Brake Co. He started with Bendix-Westinghouse as a senior designer in 1949, later he was project engineer and advanced product design engineer.

GENE CORMANY has been appointed executive engineer, to be in full charge of the engineering staff at Zollner Corp. For the past 17 years Cormany has been working with internal combustion engines.

WILLIAM H. ROWLEY has been appointed manager, military requirements, Aeroquip Corp. Formerly he was manager of Aeroquip's Dayton office. His new position will involve technical liaison work with regulatory departments of military aeronautical services, the Civil Aeronautics Administration, and SAE technical committees.

CLAUDE T. McCLURE has been made director of service at the Chrysler Division, Chrysler Corp. He has been with Chrysler Corp. since 1948 when he became Central service representative in the Miami district. In January 1955 he was assigned to Detroit as technical manager in the service department of Chrysler Division.

ALLAN CHILTON has been appointed manager of the new Westinghouse engineering center, Westinghouse Electric Corp., for corporate advanced design and development programs. Prior to his new assignment, Chilton was chief engineer of Westinghouse Aviation Gas Turbine Division, Kansas City, Mo.

WHITNEY COLLINS, formerly chief engineer, Gas Turbine Division, Continental Aviation and Engineering Corp., has joined Solar Aircraft Co. as executive assistant to the president. He will engage primarily in long-range planning for Solar.

MAHARAJ KRISHEN MEHTA, formerly technical director at the Capsulation Service Ltd., in Bombay, India, has been made an engineer-in-charge of instrumentation, Bhilai Steel Project, Ministry of Steel, Mines and Fuel, Government of India.

From August 1956 to March 1957, Mehta was sent by the Government of India to the U.S.S.R. to work and visit several design organizations, steel works, and instrument manufacturing plants operated by the Ministry of Iron and Steel, Government of U.S.S.R.

EDWIN R. JONES has been made service representative at the Edsel Division, Ford Motor Co., Dallas, Tex. Jones formerly was an engineer test pilot at the Temco Aircraft Corp.

SAUL MANDEL has been made thermodynamics engineer at the Temco Aircraft Corp., Dallas, Tex. Formerly Mandel was design engineer, Aerojet-General Corp., Sacramento, Calif.

V. ERIC GOUGH has been awarded the Crompton-Lanchester Medal for Session 1955/56 from the Institution of Mechanical Engineers, London, England. Gough received this award for his joint paper "Front Suspension and Tyre Wear."

JOSEPH A. SCIANNA, formerly experimental engineer at the Pratt & Whitney Aircraft Division, United Aircraft Corp., in Hartford, Conn., has been made test engineer in the development program of the prototype J-83 turbojet, at the Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, L. I.

RAYMOND L. GEE, formerly junior engineer at the Cadillac Motor Car Division, General Motors Corp., has been made experimental engineer for the company.

GAYLORD UNDERWOOD has been made sales engineer with the Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc. Formerly he was sales engineer at the Wilkening Mfg. Co., Detroit.

WILSON PAYNE GREEN is now technical director, research & development department of the Parker Pen Co., Janesville, Wis. Formerly he was director of product development in the research and development department of the Armour Research Foundation.

JOHN W. LESTER has been made an instructor in the Marine Engineering Department of the U. S. Navy, Annapolis, Md. Formerly he was squadron engineer, U. S. Navy Air Base, Coronado, Calif.

DALE P. WIRE, formerly a test engineer at the Westinghouse Electric Corp., Kansas City, Mo., has been made a mechanical design-engineer of atomic weapons at the Sandia Corp., Livermore, Calif.

KURT WEIL has been appointed professor and head of the Department of Mechanical Engineering at Stevens Institute of Technology, Hoboken, N. J.

Weil has served as a consultant to several engineering firms since 1946.

JOHN E. ISAKSON has been made a flight test liaison engineer at the Boeing Airplane Co., Transport Division. Formerly he was a project engineer for the company.

J. W. JASPERSEN has been made director of sales for all company divisions of Walker Mfg. Co. of Wisc. He was formerly sales manager of the Original Equipment Sales Division.

HENRY M. PORTER has been appointed sales manager of the Original Equipment Sales Division of Walker Mfg. Co. of Wisc. He has been representing the Walker Mfg. Co. in this division for more than 18 years.

FORD MOTOR CO. CHANGES . . .

New Departure Division . . .

Stoner

Rhame

SETH H. STONER has been made general manager of the New Departure Division, General Motors Corp. Formerly he was chief engineer of the New Departure Division.

PAUL W. RHAME, a veteran of 34 years with General Motors Corp., has retired as general manager of New Departure Division.

Garbarino

Valentine

FREDERICK J. GARBARINO, formerly director of quality control, New Departure Division, General Motors Corp., has assumed a newly-created position as the division's director of sales and engineering.

RICHARD H. VALENTINE has been made chief engineer, New Departure Division, GMC. He joined New Departure in 1939, and has been engaged in ball bearing sales engineering assignments in the Detroit and Cleveland areas for many years. For the past two years he has been assistant chief engineer.

Tractor and Implement Division . . .

RAY J. MILLER has been named chief engineer, Tractor and Implement Division, Ford Motor Co. He will be responsible for all engineering operations of the division and in charge of the company's Farm Machinery Research and Engineering Center in Birmingham, Mich. Miller joined Ford in 1953 and has served as manager, general engineering and research department, Tractor and Implement Division, since that time.

CHARLES T. O'HARROW has been made chief tractor engineer in charge of the tractor engineering department, Tractor and Implement Division, Ford Motor Co. Formerly O'Harrow served as assistant chief tractor engineer of the division.

ROBERT L. ERWIN has been named manager of the newly designated engineering administration and services department, Tractor and Implement Division, Ford Motor Co. Erwin has been project engineer in the former general engineering department in charge of development of an experimental tractor powered by a free-piston turbine engine.

SIR ROY FEDDEN, one of Britian's leading aeronautic experts, is the author of a recently published book, "Britian's Air Survival."

The British aircraft industry, Fedden feels, has failed to keep abreast of post-war development. He explains why improvement is vitally necessary. Fedden outlines a program for the next ten years, and also explains the policies and methods that he feels must be used to make that program possible.

ROBERT F. BROWN is now with The Martin Co., as senior engineer, System Test Division, Denver, Colo. Formerly he was professor of mechanical engineering at the University of Colorado and served as faculty advisor to the SAE Student branch there for 9 years.

He has also served as chairman, vice-chairman, and secretary of the SAE Colorado Group, and has been on its Governing Board.

LOTHROP M. FORBUSH has been named assistant to **MAURICE A. THORNE**, engineer in charge of the vehicle development group of the Engineering Staff, General Motors Corp. In his new position Forbush will head up the automotive ordnance section of the vehicle development group.

Forbush joined GMC in 1946 as a design engineer in the structure and suspension development section, Engineering Staff. In 1951 he was senior project engineer in the automotive ordnance section and in 1953 made staff engineer.

RONALD V. HUTCHINSON, formerly assistant to the engineer in charge of vehicle development, has transferred to the staff of the vice-president in charge of the Engineering Staff, to undertake a special assignment.

Hutchinson has been associated with GMC since 1919, serving with what is now the Oldsmobile Division, GM Research and the Fokker Aircraft Corp. In 1941 he joined the Engineering Staff and in 1952 became assistant head of the vehicle development section, directing the automotive ordnance section.

RAY MATLOCK is now with customer relations, sales department, at the Curtiss Wright Corp., Wright Aeronautical Division. Formerly he was sales manager in the Eastern Division of the Meletron Corp., Los Angeles.

RICHARD O. GORDON, formerly field engineer at the Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., has been made head of Power Steering Sales and Engineering at Vickers, Inc.

JOHN E. McDONALD, formerly contact engineer at the Chrysler Corp., Detroit, has been made second officer (flight engineer) with Delta Air Lines, Atlanta, Ga.

JACK W. COTTON has been made test engineer at the aircraft landing gear department of Bendix Product Division, Bendix Aviation Corp. Formerly he was test engineer at the Vertol Aircraft Corp.

JOHN H. EATON, formerly associate aircraft engineer at the Lockheed Aircraft Corp., has been made experimental engineer at the Pratt & Whitney Aircraft Division, United Aircraft Corp., West Palm Beach, Fla.

BANSUN CHANG has been made engineering specialist at the Marquardt Aircraft Co., Van Nuys, Calif. Formerly he was research engineer at the Hallicrafters Co., Chicago.

DONALD GEORGE HALL has been made senior test engineer at the Hamilton Standard Division of the United Aircraft Corp. Formerly he was in the U. S. Army in North Carolina.

DARL F. CARIS has been made engineer in charge of the reorganized power development section of General Motors Corp.'s Engineering Staff. The newly-formed power development section combines GM Research Staff's auto-

Caris

motive engine department and operations of the present power development section.

Formerly Caris was head of GMC's Research Staff's automotive engines department. He joined the GMC Research Staff in 1926, was project engineer in 1931, and head of automotive engines department in 1938.

LLEWELLYN M. K. BOELTER, chairman of the department of engineering at the University of California, has received the Annual Medal of the American Society of Mechanical Engineers. The medal is awarded to a person who is considered to have rendered distinguished service to engineering and science. Boelter was cited for "his outstanding contributions . . . as engineer and educator."

Dolza

JOHN DOLZA has recently set up the Dolza International Engineering Co. with headquarters in Fenton, Mich., and a technical branch in Turin, Italy. Through this organization, Dolza plans to exchange technical help and purchase manufacturing equipment and raw materials for the needs of European industries, particularly in the Latin nations.

Dolza Engineering Co., a second Dolza-organized firm, will be a technical office, located also at Fenton. It will concentrate on U. S. engineering and technical projects.

Dolza enters these new fields following 30 years with General Motors Corp., during which he held increasingly important engineering responsibilities. Most recently, he was in charge of the power development section of the Corporation's Engineering Staff.

In 1942 Dolza received the SAE Manly Memorial Medal for co-authorship of a paper on "Correlation of Ground and Altitude Performance of Oil Systems."

GMC'S BUICK DIVISION CHANGES . . .

OLIVER K. KELLEY has been made chief engineer of Buick Motor Division, General Motors Corp. Formerly Kelley served as head of the transmission development group, GMC. He joined the GM engineering staff in 1937 and became engineer in charge of the transmission group in 1940.

Kelley

VERNER P. MATHEWS has retired as chief engineer of Buick, and will continue with the company on a special assignment to the general manager. Mathews started with Buick in 1926 and served as assistant chief engineer of Moraine Products, GMC, and since 1951, Buick's chief engineer.

Mathews

The 2nd World Metallurgical Congress, convening in Chicago, November 2–8, under sponsorship of the American Society for Metals, has picked four SAE members for panel moderators.

ALBERT J. PHILLIPS, vice-president and director of research, American Smelting and Refining Co., will serve on Practical Aspects of Degassing; **H. N. BOGART,** manager, Manufacturing Research Dept., Ford Motor Co.,—Machining of Steel. He will also serve as co-moderator for the panel on Testing in Product Development; **WALTER HOLCROFT,** president, Holcroft and Co.,—Carburizing; **M. F. GARWOOD,** chief materials engineer, Chrysler Corp.,—Steel Gears.

W. D. DYSART has been made research engineer in the Research & Development Laboratories of the Pure Oil Co., Crystal Lake, Ill. Formerly he was test engineer at the Cummins Engine Co., Inc.

LES VILAND and **CARL CHAKMAKIAN,** economy run experts, recently drove in a test to determine the time-saving and economy advantages of automobile turnpike traveling. The test will be sponsored by the Indiana Toll Road Commission and American Motors Corp. and will be conducted over the Indiana, Ohio, Pennsylvania, and New Jersey turnpikes in a trip between Chicago and New York City.

WILLIAM H. SPRINGER has been made product senior draftsman at the Chrysler Corp., Detroit. Formerly he was first class draftsman at the Le-Tourneau-Westinghouse Co., Peoria, Ill.

JOHN V. MOTTO has been made product development engineer at the Bohn Aluminum and Brass Corp. Formerly he was staff engineer at Harley Earl Inc., Center Line, Mich.

Continued on page 116

Obituaries

RALPH C. ARCHER . . . (M'45) . . . vice-president, manufacturing, International Harvester Co. . . . joined the company in 1919 as vice-president in charge of engineering of tractors and component parts, in charge of plants of same . . . died Aug. 11 . . . born 1892 . . .

WILLIAM A. COMPTON . . . (M'50) . . . head, technical data section, engine department, Detroit Diesel Engine Division, General Motors Corp. . . . formerly was manager, research and development, Jet Division, Thompson Products Inc. . . . member SAE Engine Committee's Diesel Engine Test Code Sub-Committee . . . died Aug. 17 . . . born 1921 . . .

DAN S. EDDINS . . . (M'39) . . . retired in 1952 as president of Plymouth Division, Chrysler Corp. . . . joined General Motors Corp. in 1918 in Chevrolet Division, served as president of GMC's Olds Motor Works in 1925 . . . transferred to Chrysler in 1933, named president of Plymouth in 1934 . . . died Aug. 24 . . . born 1884 . . .

ELMER F. HEIMBACH . . . (M'49) . . . vice-president of engineering, Brummer Seal Co., Chicago Heights, Ill. . . . joined the company in 1945 . . . died June 29 . . . born 1899 . . .

HARRY A. KNOX . . . (LM'05) . . . one of the founders of SAE . . . pioneer in automotive industry, designed and built a four-cylinder auto in 1895 . . . retired from U. S. Army Corps of Engineers . . . died June 2 . . . born 1875 . . .

SAE Section Meetings

CANADIAN

October 16 . . . Speaker Ray J. Standish, manager, Central Staff Placement, Thompson Products Inc., Cleveland, Ohio. Hotel Queensway, St. Catharines, Ont., Canada

CENTRAL ILLINOIS

October 28 . . . "Turbochargers." Elks Club, Springfield, Illinois. Dinner 6:30 p.m. Meeting 7:45 p.m.

CHICAGO

November 12 . . . Harold Skinner, sales engineer, Fuller Manufacturing Company, Transmission Division, Kalamazoo, Michigan.—Discussion of "Automotive Transmissions Available for Truck and Bus Applications." Hotel Knickerbocker, Chicago. Dinner 6:45 p.m. Meeting 8:00 p.m. Special Feature: Social Half Hour 6:15 p.m. to 6:45 p.m.

CLEVELAND

October 14 . . . Dr. Henry E. Birkenhauer, S. J., director of the Seismological Observatory of John Carroll University.—"The International Geophysical Year." Manger Hotel.

DETROIT

October 15 . . . Two Speakers: J. C. Zeder, vice president, engineering—special advisor to president, Chrysler Corp.—"Portrait of Tomorrow's Engineer." S. S. Attwood, University of Michigan.—"Engineering and the North Campus." University of Michigan, Ann Arbor, Michigan. Tour 4:00 p.m. Dinner 6:30 p.m. Technical Session 8:00 p.m. Special Feature: Tour of the New Automotive and Aeronautical Engineering Laboratories, University of Michigan.

October 28 . . . N. L. Blume, chief engineer, Edsel Division, Ford Motor Company, Dearborn, Michigan.—"Engineering the Edsel." Masonic Temple, Fountain Room. Dinner 6:30 p.m. Dinner Speaker: Bill Fleming, Sports Director, WWJ. Meeting 8:00 p.m. Open to members of other societies.

INDIANA

October 17 . . . J. S. Fouch, applied science representative, International Business Machine Corp.—"Electronic Computer—New Tool for Engineers." Indianapolis Naval Armory. Dinner 7:00 p.m. Meeting 8:00 p.m.

KANSAS CITY

October 17 . . . Transportation and Maintenance. World War Memorial Building. Dinner 7:00 p.m. Meeting 8:00 p.m.

METROPOLITAN

October 17 . . . Thursday Luncheon Meeting. Speaker representative GMC Overseas. Subject: Vauxhall Victor and Opel Rekord. Beverly Hotel, 50th Street and Lexington Avenue. 12 Noon. Price is $2.75 including tip.

October 24 . . . Aeronautic Activity Meeting. Thomas L. Brewer, Research Division, Curtiss-Wright Corporation.—"The Conquering of Noise in Turbojets." Henry Hudson Hotel, 57th Street and 9th Avenue. Meeting 7:45 p.m.

MID-MICHIGAN

November 4 . . . Speaker Dr. R. H. Boundy, vice-president and director of research, Dow Chemical Co., Midland, Michigan. Coffee Speaker: D. L. Gibb, sales manager, Plastics Division, Dow Chemical Co., Midland, Michigan. U.M.W.A. Union Hall, Midland, Michigan. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Feature: Plant tour Dow Chemical Co.,—Saran Plant, 4:45 p.m. to 6:15 p.m.

MONTREAL

October 21 . . . Rodney Kox, manager, Transport Equipment Division, R. G. Letourneau Co., Longview, Texas.—"Earthmoving Equipment." Mount Royal Hotel. Dinner 7:00 p.m. Meeting 7:45 p.m.

NORTHWEST

October 18 . . . Homer T. Seale, president, Homer T. Seale Co., La Puente, California.—"Brake Balance Between Axles—Original Design and Field Correction." Stewart Hotel. Dinner 6:30 p.m. Meeting 7:30 p.m.

OREGON

October 17 . . . Homer T. Seale, president, Homer T. Seale, Inc., La Puente, California.—"Brake Design and Field Correction." Imperial Hotel. Dinner 7:00 p.m. Meeting 8:00 p.m.

PITTSBURGH

October 22 . . . F. W. Lohmann, Kloeckner-Humboldt-Deutz A. G. & Diesel Energy Corp., New York, N. Y.—"The Air Cooled Diesel Engine Advantages and Applications." Mellon Institute Auditorium. Dinner 6:30 p.m. Meeting 8:00 p.m.

SOUTHERN CALIFORNIA

October 14 . . . Neil L. Blume, chief engineer, Product Engineering Office, Edsel Division, Ford Motor Co., Dearborn, Michigan.—"The Edsel Story." Rodger Young Auditorium. Dinner 6:30 p.m. Meeting 8:00 p.m.

SPOKANE INTERMOUNTAIN

October 14 . . . Desert Caravan Inn
November 11 . . . Desert Caravan Inn

ST. LOUIS

November 12 . . . Charles J. Wilhite, assistant manager, New Products, Cummins Engine Co., Columbus, Indiana.—"The Case for the Diesel Engine." Congress Hotel. Dinner 7:00 p.m. Meeting 8:00 p.m.

WASHINGTON

October 15 . . . Field Trip to Naval Research Laboratory beginning with Luncheon at 12:30 p.m. The tour includes: (1) Radio Astronomy, (2) Earth Satellite Program, (3) Surface Chemistry related to Lubrication and (4) Research Reactors.

WESTERN MICHIGAN

November 5 . . . S. L. Milliken, administrative engineer, Cadillac Motor Car Division, GMC., Detroit.—"Cadillac's Air Spring for the Eldorado Brougham." Doo Drop Inn, Muskegon. Dinner 7:00 p.m. Meeting 8:00 p.m.

WICHITA

October 17 . . . M. J. (Jerry) Gordon, chief of preliminary design, Beech Aircraft Corp., Wichita, Kansas.—"The Beech Travel Air." Innis Tea Room. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Feature: Slides.

WILLIAMSPORT

November 4 . . . W. Paul Eddy, 1957 SAE President.—"From Pistons to Jets." Moose Club Auditorium. Dinner 6:45 p.m. Meeting 8:00 p.m.

Briefs of SAE PAPERS

Continued from page 6

all of these associated with suspension; description of test apparatus, operation and procedure; test results on tires; illustrations.

Tires for High Speed Operation, M. P. HERSHEY. Paper No. 125. Presented June, 1957, 7 p. Findings of survey made of 2422 cars traveling on highways in Southwestern part of United States indicate that drivers make use of power and speed built into cars and also indicate to tire engineer what speeds modern passenger car tire must be designed to handle; effect of speed on tire performance; factors necessary to secure good high speed tire performance; features of high speed Firestone "500" tire, "Super Sports 170"; graphs.

How European Motor Car Design Evolved, H. L. BROWNBACK. Paper No. 126. Presented June, 1957, 8 p. Various stages of design trends are outlined; effect of racing changed design trend from 2-cyl to 4-cyl engine; other trend setters such as front-wheel drive car by Citroen in 1933; rear engined cars.

Previewing French Motor Car Design During Next Five Years, F. L. PICARD. Paper No. 127. Presented June, 1957, 9 p. Report represents result of collaboration of Presidents of Technical Sections of French Automotive Society; predictions on French economy and factors which will influence motor car design; powerplant placement and drive methods; progress to be expected with respect to engine, transmissions, suspension, steering gear, brakes, electrical equipment, and coach work.

Birth of Retractable, B. J. SMITH. Paper No. S7. Presented Feb., 1957 (Detroit Section Meeting), 14 p. Various design stages and problems encountered in developing true hardtop convertible, retractable hardtop Ford 1957 model; description of three prototypes built for test program and final model; sketch of automatic header lock; top linkage assembly and operation of hardtop system; illustrations.

Requirements for Truck Performance Evaluation, C. T. KOPE. Paper No. S8. Presented Apr., 1957 (Southern Calif. Section), 9 p. Evaluation of performance of components, and of vehicle as entity, as it is affected by its engine power; effect of load or overload is shown by component evaluation of 2-ton truck of 17,000 GVW, overloaded to 24,000 lb; torque and horsepower and their relationship; horsepower rating most important single factor in determining performance.

Ride Engineer's Experience with Instrumentation, R. R. PETERSON. Paper No. 136. Presented June, 1957, 6 p. Changes in field of ride development during past 20 yr; laboratory performance of tests currently used and evaluation of ride engineer's job; road vehicle instruments for special purpose tests and use of instruments as supplements to manpower; instrumentation used on road trip such as 2-way radios, dictograph, accelerometers and suspension bumper contact indicators.

Truck Tire Noise, T. A. ROBERTSON Paper No. S9. Presented Feb., 1957 (Detroit Section), 7 p. Use of smooth drum technique at Firestone test station, Columbiana, Ohio, to illustrate, on various types of tires, basic principles of relationship of tire noise and tread design; four basic available tread designs are discussed; tire noise

Continued on page 112

Briefs of SAE PAPERS

Continued from page 110

can be controlled by proper selection of tires and good maintenance practices to avoid uneven wear.

Piston Burning — Hydrodynamic Testing of Gearcases on Outboard Motors, K. ROBINSON. Paper No. S10. Presented Mar., 1957 (Twin City Sec.), 9 p. At Scott Atwater Mfg. Co. examination of 40-hp motors which had pistons burn showed pre-ignition on one cylinder of multicylinder engine due to spark caused by magneto failure; discovery led to new output test method of testing pistons by introducing pre-ignition and rating pistons according to time of operation before failure occurred; tabulation of operating times; drag tests on gearcase designs and results.

Fuel Consumption Studies on Two Stroke Gasoline Engine, H. GRANT. Paper No. S11. Presented Mar., 1957 (Twin City Section), 8 p. Characteristics of outboard motor boat operation and factors providing for reduced part throttle fuel consumption; graphs of specific fuel consumption of 10, 33, and 40-hp engine; study on part throttle fuel consumption to determine consumption versus engine rpm at fixed spark timing with special tank wheel propeller load, and results; means of improving mid-range specific; future trends.

Maintenance—Basic Responsibility, E. W. WRIGHT, J. R. COWLES. Paper No. S12. Presented Mar., 1957 (Indiana Section), 3 p. Role of engine manufacturer and his representative, and truck fleet owner and his operating personnel, in sharing basic responsibility with regard to maintenance; approach at Cummins Engine Co. is shown by example of development of diesel fuel system and other designs aimed at providing easier maintenance and accessibility to engine for repair; activity of "Pilot Installation Center".

What Is New in Vehicle Maintenance, G. H. MAXWELL. Paper No. S13. Presented Apr., 1957 (Baltimore Sec.), 8 p. Five basic items which are foundations of any successful fleet maintenance system are considered: proper vehicle selection; good preventive maintenance system; best possible fuel and lubricants; use of labor saving instruments and tools; training of personnel in accepted and approved methods.

MATERIALS

Status of Accelerated Testing of Automotive Rubber Parts, W. J. SIMPSON. Paper No. 134. Presented June 1957, 16 p. Types of aging which must be considered carefully in automotive parts and some of static tests currently in use to evaluate aging characteristics; air aging; ozone aging; light aging of colored parts; humidity and fluid aging tests.

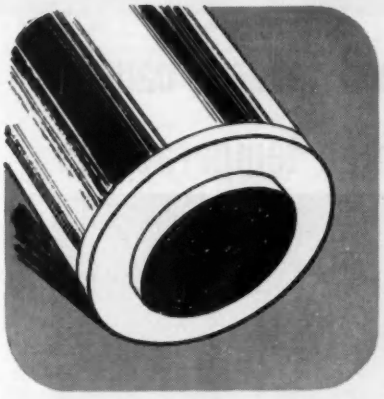
Status of Accelerated Weathering of Automotive Organic Coatings, M. M. GERSON. Paper No. 135. Presented Jan., 1957, 12 p. Paint industry, in form of special committees, is attempting to provide basic set of statistics from which individual companies may benefit; three basic functions of suitable accelerated test schedule; Florida exposures and problems of variables of Florida weathering; most common types of failure to measure are: blistering, chalking and bronzing, color change, checking, dulling, glass retention; tables and curves.

NUCLEAR ENERGY

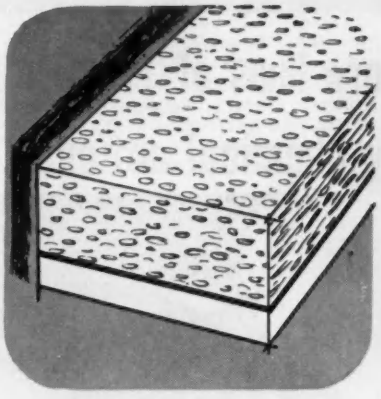
Progress Report on Nuclear Power, A. C. JOHNSON. Paper No. S14. Presented Feb., 1957 (Montreal Sec.), 7 p.

Continued on page 115

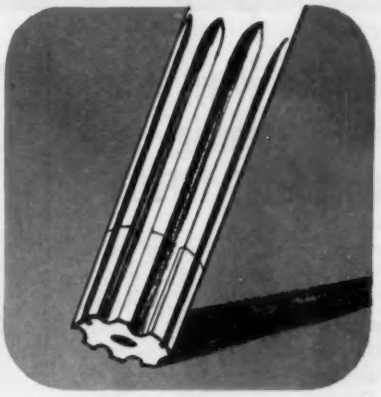
NOW—improved production through faster and better bonding with R/M Ray-BOND® Adhesives



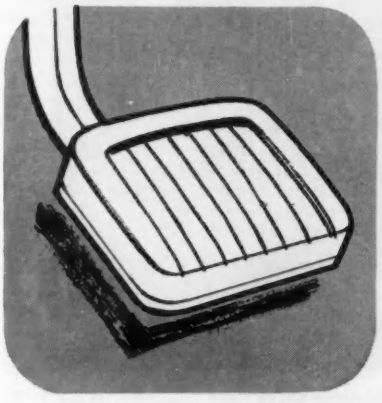
Butyl rubber foot to stainless steel tank



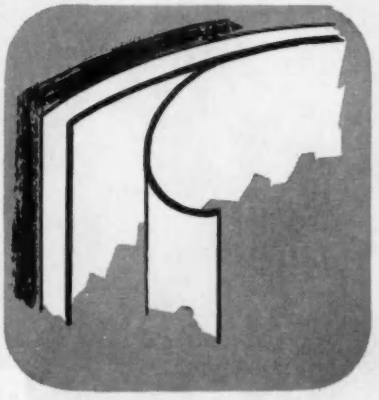
Synthetic foam to metal



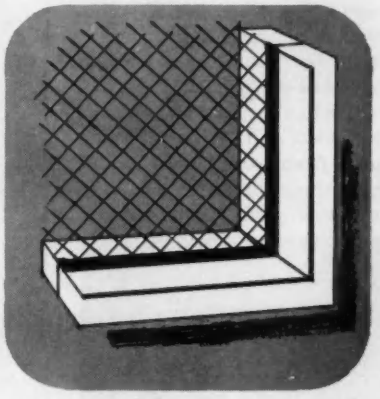
Ceramic tips to steel shanks



Natural rubber to clutch pedal



Etched "Teflon"* to steel



Rubber seals to stainless steel screens

FOR THESE AND COUNTLESS OTHER APPLICATIONS

NEW R/M Ray-BOND ADHESIVES CAN BE TAILORED TO YOUR NEEDS

Whether or not bonding, laminating, sealing or coating are now factors in your operations, the new specialized line of R/M Ray-BOND adhesives, protective coatings, and sealers may have important advantages for you. Shown above are a few of thousands of applications where use of modern bonding techniques can simplify and improve product design and eliminate troublesome fastening problems.

*A Du Pont trademark

R/M initiated the production of bonded assemblies more than 20 years ago. Over the years we have acquired a wealth of experience that can help you cut costs and simplify operations in innumerable bonding applications. Call on our engineers to work with you in developing adhesives, protective coatings, and sealers to meet your specific requirements. Adhesives Department, RAYBESTOS-MANHATTAN, INC., Bridgeport, Conn.

Send for free copy of R/M Bulletin No. 650A, containing engineering information on Ray-BOND adhesives, protective coatings, and sealers.

R/M

RAYBESTOS-MANHATTAN, INC.

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DU PONT

Better Things for Better Living
. . . through Chemistry

AUTOMOTIVE ENGINEERING NEWS

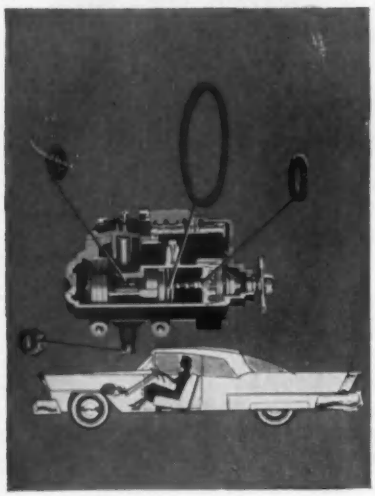
LATEST PROPERTY AND APPLICATION DATA ON

TEFLON® tetrafluoroethylene resins

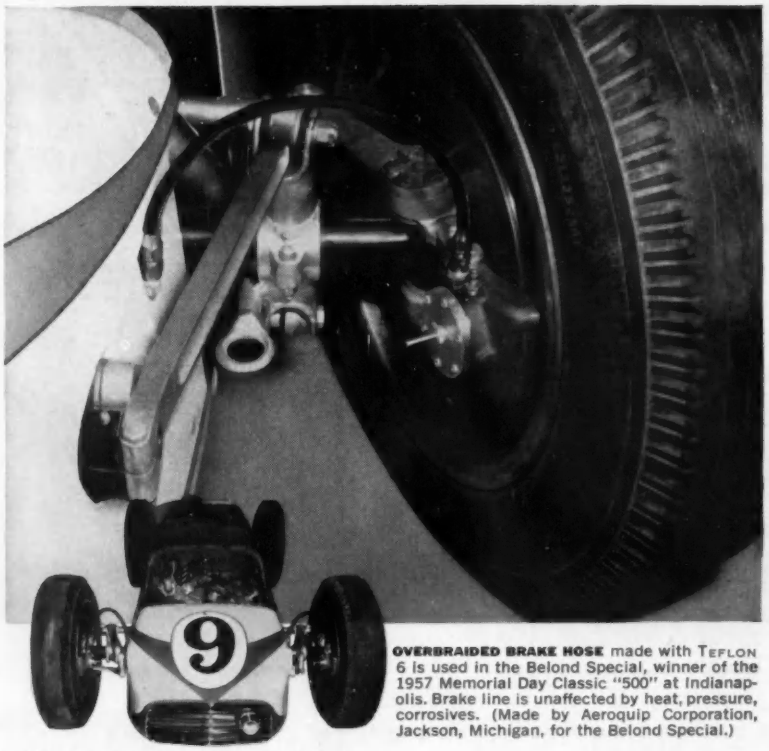
Less break-away effort, smoother steering, with parts made of TEFLON 1

The power-steering unit shown below makes parking almost twice as easy — allows more relaxed driving. Featured in this automotive advance are the seals, piston ring, and lock-nut seal ring made of TEFLON 1, which have substantially reduced break-away effort. Even under high pressure they allow the shaft to turn freely, thus solving a binding problem caused by other materials.

TEFLON tetrafluoroethylene resins have the lowest coefficient of friction of any solid, with a measured kinetic and static coefficient of 0.04. They are suitable for use from —450°F. to +500°F., remain relatively flexible, and maintain good impact strength over this range.



Hose lines of TEFLON® tetrafluoroethylene resins end failures caused by chemical action... high temperatures



OVERBRAIDED BRAKE HOSE made with TEFLON 6 is used in the Belond Special, winner of the 1957 Memorial Day Classic "500" at Indianapolis. Brake line is unaffected by heat, pressure, corrosives. (Made by Aeroquip Corporation, Jackson, Michigan, for the Belond Special.)

Reliability of performance and the ability to stand up under terrific punishment were the reasons for choosing overbraided brake lines made with TEFLON 6. The designer of the winning car in the Indianapolis racing classic selected these lines because they withstand all varieties of automotive chemicals and operate reliably even at a temperature of 500°F. Because of its very low volumetric expansion, the TEFLON resin used in the lines gives a firm pedal to the brake system that previously had been impossible to achieve. Hose lines of TEFLON 6 easily withstand the vibration and flexing of a grueling track run.

Du Pont TEFLON tetrafluoroethylene resins may help make your product a winner. Send the coupon for interesting technical facts and more end-use ideas.

Watch the Du Pont "Show of the Month." 90 minutes of the very best in live television — CBS-TV network.

TEFLON®
is a registered trademark...

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the tetrafluoroethylene resins discussed herein. This registered trademark should not be used as an adjective to describe any product, nor should it be used in whole, or in part, as a trademark for a product of another concern.

SEND FOR INFORMATION

For additional property and application data on Du Pont TEFLON tetrafluoroethylene resins, mail this coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 510, Du Pont Building, Wilmington 98, Delaware

Please send me more information on Du Pont TEFLON tetrafluoroethylene resins. I am interested in evaluating these materials for_____

*Name*_____

*Company*_____ *Position*_____

*Street*_____

*City*_____ *State*_____

*Type of Business*_____

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

Briefs of SAE PAPERS

Continued from page 112

General resume on production of nuclear power; characteristics of reactors; present status of power reactors in various countries, particularly United Kingdom, Canada, and United States; cost of power; possibility of fusion processes.

PRODUCTION

Improvement of Welded Structures by Subsequent Forging Operations, W. WOLLERING, E. LUNDBY. Paper No. 129. Presented June 1957, 15 p. Technique by Ladish Co. utilizing forging of welded structures resulted in development of mechanical properties in welded sections of metal approaching properties of wrought parent metal; how process was developed; use of integrally forged metals of varying composition such as carbon steel and SAE-4340 and combinations of stainless steel; forging of welded plates and disks.

Template Tooling, W. R. WILSON. Paper No. 130. Presented June 1957, 10 p. Process of fabricating simple, low cost blanking tool, made of plywood, steel rule, rubber and glue and mild steel, developed by Template Industries, Inc., Brooklyn, N. Y., adopted by A. O. Smith Corp., manufacturers of automobile and truck frames and parts, to provide temporary tooling for initial production requirements, in advance of permanent tools; as much as 250,000 pieces were produced from single die; tool costs.

Tips on Aids for Body Die and Tool Construction, E. R. KALIS. Paper No. 80A. Presented Mar., 1957, 3 p. Epoxy resin used for construction of die aids, checking fixtures, and duplicate body die models, is of exothermic heat reaction type, therefore, improper usage causes over-heating which is detected in several ways; how to correct or eliminate problems such as shrinkage, warpage, wavy surfaces, twist, chipping and breaking of corners and edges.

Development and Application of Modern High-Vanadium Die Steel, W. E. PETERSON. Paper No. 80B. Presented Mar., 1957, 4 p. Primarily developed for draw dies by Allegheny Ludlum Steel Corp., Ottawa 60 is special die steel of unusual analysis (3¼% carbon 12% vanadium) with many desirable properties, high wear resistance, low coefficient of friction, etc; examples of exceptions where Ottawa is suitable as trim die.

Techniques and Materials for Low Cost Tooling, F. S. ALTMAN. Paper No. S15. Presented Feb., 1957 (Detroit Section), 20 p. Groups involved in all steel body building at Fisher Body Div are management, production engineering, tool engineering, construction and production groups; types of tooling aids, coordination tools and techniques used; plastic panels; product checking fixtures; types of material and manufacturing tools; standardization; tryout programs; low cost tooling for low volume production; new materials and new techniques.

Presented here are brief digests of recently presented SAE papers. These papers are available in full in multilith form for one year after presentation. To order, circle the numbers in the "Readers Information Service" blank on page 5 corresponding to the numbers appearing after the titles fo the digests of interest to you.

These digests are provided by Engineering Index, which abstracts and classifies material from SAE and 1200 other technical magazines, society transactions, government bulletins, research reports, and the like, throughout the world.

About SAE Members

Continued from page 107

ERNEST WALTER HIVES, chairman of Rolls-Royce Ltd., has retired after 48 years with the company.

Hives joined Rolls-Royce in 1908, two years after it was formed, and subsequently was named manager of the experimental department. He became general works manager in 1936 and a director in 1937.

In 1939 Hives received the SAE Manly Memorial Medal for co-authorship of a paper on "High Output Aero Engines."

J. GARRETT FORSYTHE, JR. has been made mechanical engineer, electro-mechanical development at the Remington Rand-UNIVAC, Division of Sperry Rand Corp. Formerly he was a design engineer at the Curtiss Wright Corp., Turbomotor Division, Princeton, N. J.

JOHN K. ZAISER has become affiliated with the California Polytechnic College at San Luis Obispo, Calif. Formerly he was design engineer at North American Aviation, Inc., International Airport, Los Angeles.

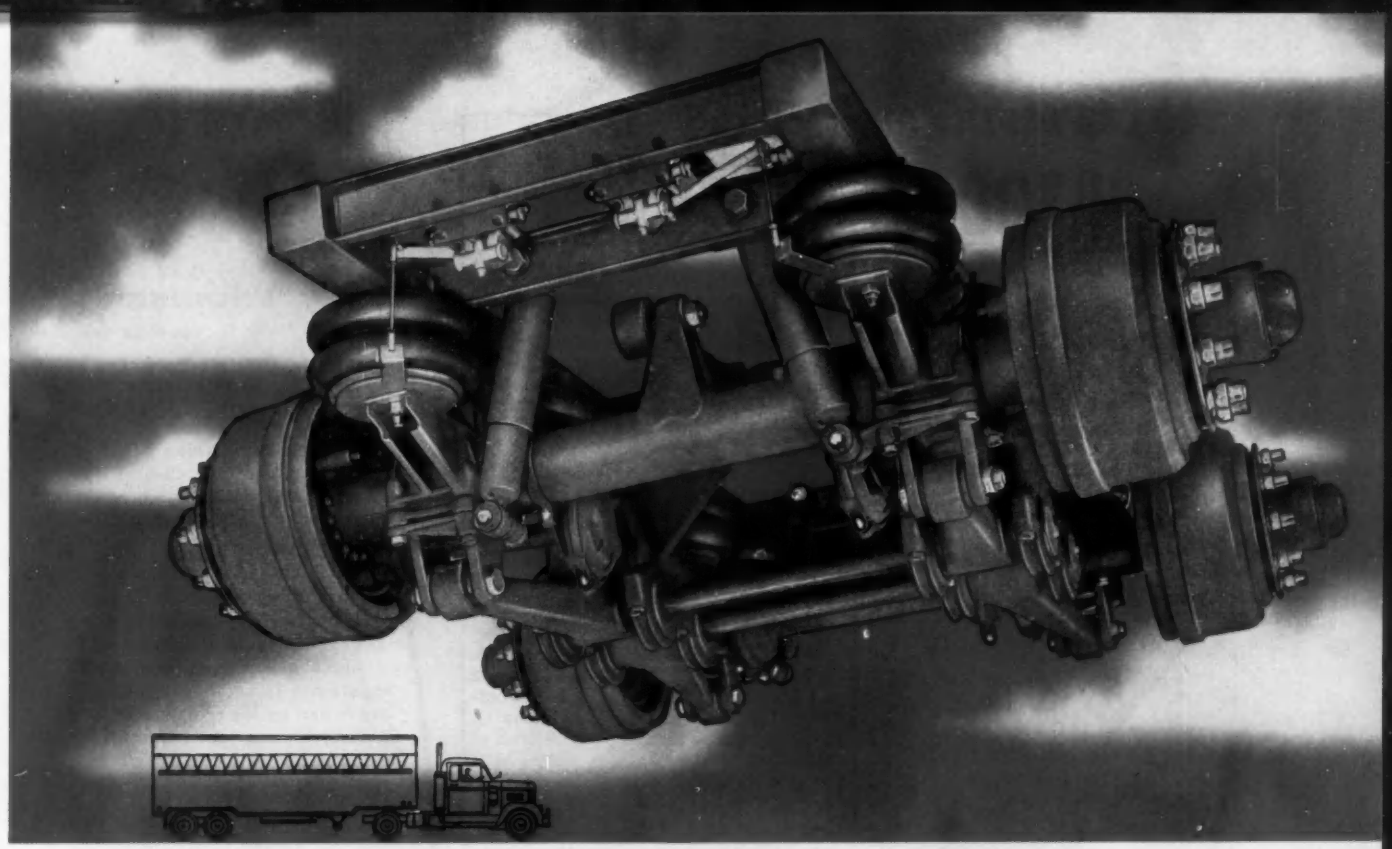
SALVATORE J. DiBARTOLO has joined Stromberg-Carlson Telecommunication Division, General Dynamics Corp., as an engineer. Before joining Stromberg-Carlson, he was employed by General Electric Co., and Carrier Corp.

ROY ALFRED RENNER is now a mechanical engineer at the Bigge Drayage Co., in Oakland, Calif. Formerly he was an instructor of general engineering at the Oregon State College, Corvallis, Oreg.

W. THOMAS H. MAC NEW has been appointed editor of "Aircraft and Missile Manufacturing", a new publication of the Chilton Co., Philadelphia.

Mac New was formerly Eastern editor of "Automotive Industries." Many of his articles have been incorporated in a recently published book, "Applied Automation".

Continued on page 118



TONS OF HIGHWAY CARGO
FLOAT ON AIR

with the new Clark Air Suspension System for semi-trailers

Damage to fragile goods—to perishable cargo—to empty running vehicles can be *minimized* by the new Clark Air Suspension unit.

This unique undercarriage, suitable for installation on new or in-use semis, allows both trailers and cargo literally to "float on air"!

Smooth, soft ride . . .

Doughnut-shaped "air-springs" carry full weight of trailer and cargo, absorb road shock, "flatten" even *rough* highways to a surprising degree. Ride actually approaches passenger-car softness!

High stability . . .

Lateral roll and sway are minimized by ingenious system of pivoted torque arms and torsion bars which take full force of side loads and absorb torsion resulting from brake torque.

Automatic load leveling . . .

When loading or unloading trailer, air reservoirs automatically adjust to support trailer bed at normal running height.

Versatile package unit . . .

All Clark Air Suspension assemblies come as complete packages, ready for installation. Parts are interchangeable between single and tandem units. Either suspension assembly can be used on new trailers or those already in operation.

Lower maintenance costs . . .

Because compressed air does the flexing and rubber mountings are employed, no lubrication is needed. Tanker operators will find that tank splitting and cracking of returning "empties" is minimized. Operators of other types of trailers will also find their trailers lasting longer and requiring less maintenance.

Weight advantages . . .

Trailer manufacturers using the Clark Air Suspension System can lighten frame and body construction, increase longevity —without sacrificing load-carrying ability.

Why not investigate . . .

Whether you manufacture highway semi-trailers or operate them . . . whether you haul eggs or engines . . . whether one trailer or a hundred are involved . . . it will pay you to get the facts on Clark's new Air Suspended Trailer Axles. Ask us for detailed, illustrated Brochure No. AS-500

CLARK EQUIPMENT COMPANY
Buchanan 5, Michigan

CLARK® EQUIPMENT

About SAE Members

Continued from page 116

RICHARD L. GATES has been made chief engineer at Prescott-Sterling, Inc., Menominee, Mich. Formerly he was chief engineer of Sterling Engine Division. Before joining Prescott-Sterling, he was senior product engineer at the Staff Research & Development Division, Thompson Products, Inc.

ANTHONY P. CASAGRANDE, formerly associate engineer, design, at the Douglas Aircraft Co. Inc., has been made engineer, design, turbine & development, at the Ingersoll-Rand Co., Phillipsburg, N. J.

JOHN W. LUECHT has been made staff engineer, Aeronautical Research and Development at the Ramo-Wooldridge Corp., Guided Missile Research Division. Formerly Luecht was head of analytical design, Chrysler Corp., Missile Operations.

A. J. WELCH, formerly vice-president and sales manager of the Spring Division of Borg-Warner Corp., has been named vice-president and assistant general manager.

CHARLES PACOLA has been made sales manager at the Borg-Warner Corp., Spring Division. Formerly he was assistant sales manager for the company.

DAVID F. COSGROVE has joined the Argonne National Laboratories, Lemont, Ill. He was formerly a layout draftsman at the International Harvester Co., Advanced Engineering Tractor Equipment.

CHESTER C. UTZ, formerly chief engineer for Chrysler Corp., defense engineering, since 1953, has been named executive engineer of the Defense Operations Division of Chrysler. He joined Chrysler in 1929 as a chassis designer.

E. P. BLANCHARD, an SAE Past Vice-President for Production, who now lives in Ormond Beach, Fla., left late in August for a tour of Europe and Scandinavia. Accompanied by his wife, he will return to the United States shortly before Christmas.

RAY L. MORRISON has been appointed chairman of the U. S. Savings Bonds Committee, U. S. Treasury Department, Savings Bonds Division, Somerset County. He is president of Somerset Auto Parts, Inc., and is serving on the Somerset County Development Council as president. He is retired executive vice-president at the De Vilbiss Co., Toledo, Ohio.

Electronic Cooling Package...by AiResearch

SPECIFICATIONS OF TYPICAL AIRESEARCH COOLING PACKAGE

Air Flow	60 CFM
Fan Air Inlet Pressure	18 PSIA
Fan Pressure Rise	1.2 inches water
Heat Exchanger Pressure Drop	1.0 inches water
Liquid	Water Methanol (70% Methanol)
Liquid Flow	0.4 GPM
Heat Rejection*	300 Watts
Fan Power	30 Watts, 110 V., single phase, 400 cycle
Package envelope dimensions	7 x 6 x 3 inches
Package wet weight	2.5 lbs.

*Assumes Class A (85°C.) electronic components, liquid inlet temperature to heat exchanger, 55°C. Includes heat from fan motor.

This high performance AiResearch package cools sealed and pressurized electronic equipment. The fan circulates air through the liquid cooled heat exchanger and over electronic components in a hermetically sealed module. Air cooled units are also available. Fan and heat exchanger are designed, built and packaged by AiResearch for matched performance. Package size is tailored to your individual cooling requirements.

The Garrett Corporation, through its AiResearch Manufacturing divisions, is an industry leader in components and cooling systems for aircraft, missiles and nuclear applications. This wide experience is now being offered to the electronics industry to provide a cooling package to meet any cooling requirement. Send us details of your problem or contact the nearest Airsupply or Aero Engineering office for further information.

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Continued from page 92

the "so what?" part of management coordination. Achieving a continuing operating balance is a prerequisite to economy and efficiency. Recommendations based on this comparison and analysis of progress will rectify causes rather than effects, prevent rather than cure.

To Order Paper No. 83 . . . on which this article is based, see p. 5

More Trucks to Use Automatic Transmissions

Based on paper by

R. M. SCHAEFER
Allison Division, GMC

WITHIN another year, all major truck manufacturers will have automatic transmissions available.

In addition to getting very favorable driver reaction, automatic transmissions are paying their way economically in heavy-duty trucks.

The evident move toward increased use is stimulated by the favorable operating records already being established. With increased payloads, faster haul cycles, greater safety, reduced maintenance, and better fuel economy, the automatic transmissions are helping operators to reduce their cost per ton mile. Analysis of the various types and studies of the performance data each has established in actual operations, made by GMC's Allison Division, bear out this conclusion.

To Order Paper No. 158 . . . on which this article is based, see p. 5

Oxidation Seems Best Exhaust Gas Cleanser

Based on paper by

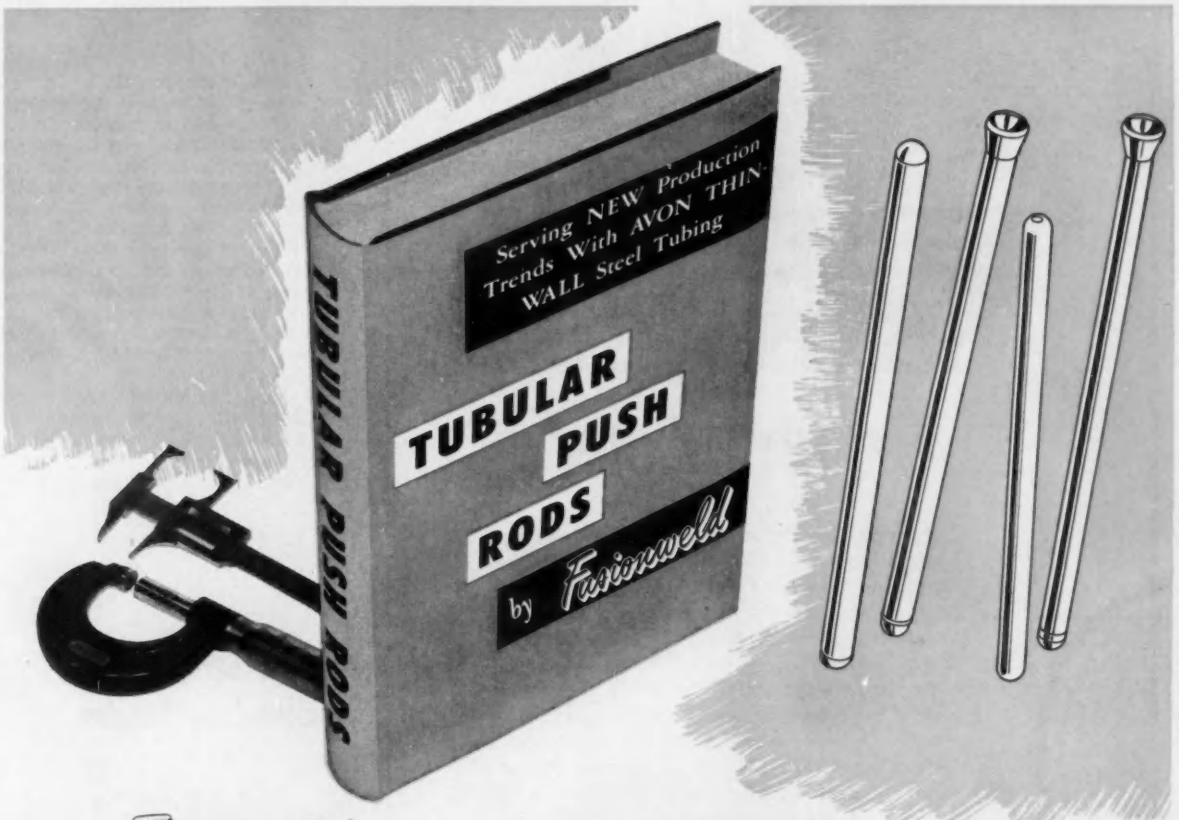
Exhaust System Task Group
Automobile Manufacturers Association

G. J. Nebel, General Motors, chairman; **C. E. Burke,** American Motors; **C. M. Elliott,** Chrysler; **R. P. Graham,** Chrysler; **R. T. VanDerveer,** Ford; **W. J. Pelizzoni,** Mack; **R. D. Randall,** Stewart-Warner

OXIDATION appears to be the most practical method for removing hydrocarbons from exhaust gases. A number of oxidation devices, both catalytic converters and afterburners, have been tested by AMA's Exhaust System Task Group.

One of these, a catalytic converter,

Continued on page 122



HOW *Fusionweld* MEETS THE CHALLENGE

The above cutaway tubular push rod section with swaged end illustrates one type of push rod design made and fabricated by Avon, then cyanide hardened. It has a low cost factor combined with great strength and toughness, plus essential concentricity.

Special hardened steel inserts (at left) provide other styles of design. These are spot welded in the tube ends, with a maximum runout of .020, to match rigid concentricity tolerances. Illustration at right shows push rod with welded insert subjected to pull-out test of 1500 pounds, which greatly exceeds critical automotive requirements.

Avon's widely accepted Fusionweld Tubular Push Rods have successfully supplanted the heavier, old style solid push rods. Startling economies, plus important improvements in engine performance today place Fusionweld push rods in the forefront of this accepted method of valve accentuation. Fusionweld has today succeeded in creating an enviable reputation for producing top quality, vibration-proof, thin-wall steel tubing. Its exclusive method of hi-cycle resistance welding, coupled with a special process of cold drawing by die sinking now provide a tubing with extreme toughness and hardness to meet the most exacting standards for a fatigue resistant product. Fusionweld's complete homogeneity of grain structure in both wall and weld gives it a new degree of tensile strength and ductility, making it highly resistant to vibration—hence ideal for innumerable automotive applications.

We welcome inquiries on Fusionweld Tubing in random or cut-to-length sizes—or fabricated and formed to your blue print specifications. Sizes 3/16" O.D. to 3/4" O.D. Plain or terne coated. Write for your copy of the Avon Tubing Guide.

AVON TUBE DIVISION
HIGBIE MANUFACTURING CO.
ROCHESTER • MICHIGAN

has shown some promise. In road tests, after warmup, this experimental converter removed approximately 80% of the hydrocarbons from the exhaust gases. The catalyst has so far been resistant to poisoning by tetraethyl lead combustion products. Life tests have not yet been completed.

Afterburners also show some promise, but none suitable for automobiles have been developed and submitted to the Group for study. Indications are that the overall efficiency of afterburners will be somewhat less than that of catalytic converters.

The Group has not yet, however, recommended any device for industry-wide consideration or application.

To Order Paper No. 173 . . . on which this article is based, see p. 5

Welded Structures Improved by Forging

Based on paper by

W. WOLLERING and E. LUNDBY

Ladish Co.

A NEW technique, utilizing the subsequent forging of welded structures, has resulted in the development of mechanical properties in welded sections of alloy materials approaching the properties of the wrought parent material.

The process may be considered an intermediate step between a weld fabrication and a one-piece forging, where the latter is impossible due to its geometric shape. However, it is without the compromising factors of strength, ductility, and design frequently associated with structures fabricated by welding methods.

Dynamically stressed, wrought parts forged from alloys such as SAE-4340 (AMS-6415), heat-treated to hardness levels resulting in ultimate tensile strengths approximating 150,000 psi, have ductility values of approximately 20% elongation and 55% reduction of area. Sections in the same alloys welded with electrodes having similar properties, when heat-treated to the same ultimate strength, will disclose ductility values substantially inferior to the wrought parent material.

To use the forging and welding processes to the fullest advantage in higher strength alloy components subjected to dynamic stresses in service operating conditions, it becomes necessary to improve the ductility of the weld material. This may be effected by heating

Continued on page 125

Garlock "makes the grade" with Galion . . . for over 30 years

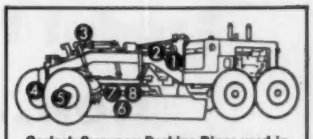
Now celebrating their 50th Anniversary, the Galion Iron Works and Mfg. Co., of Galion, Ohio is a leader in its field, and Galion Road Rollers and Motor Graders enjoy a reputation for long life and easy operation. For 30 years Garlock CHEVRON* Packings have been selected for the hydraulic cylinders of both Galion Road Rollers and Motor Graders. In fact, all eight models of the Motor Grader use CHEVRON Packings exclusively on hydraulic cylinders operating the blade, leaning front wheel, booster steering and various attachments.

The distinctive and exclusive CHEVRON design is extremely sensitive to pressure changes and ideally suited to use in shallow stuffing boxes. As pressures increase the CHEVRON Packing Rings automatically tighten to prevent leakage. As pressures decline the CHEVRON Rings instantly ease off permitting free operation without leakage. That's why cylinders using CHEVRON Packings require minimum attention and maintenance.

Exclusive CHEVRON is one more part of "the famous Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need—the only complete line. It's one reason why your Garlock representative can provide you with unbiased recommendation. Call him today or write for CHEVRON Folder AD-115.

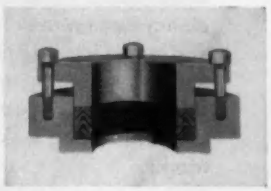
THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.



Garlock CHEVRON Packing Rings used in 8 hydraulic cylinders on Galion Motor Graders:

1. Left Blade Lift Cylinder
2. Right Blade Lift Cylinder
3. Scarifier Cylinder
4. Leaning Wheel Cylinder
5. Booster Steering Cylinder
6. Moldboard Shift Cylinder
7. Tilt Moldboard Cylinder Right
8. Tilt Moldboard Cylinder Left

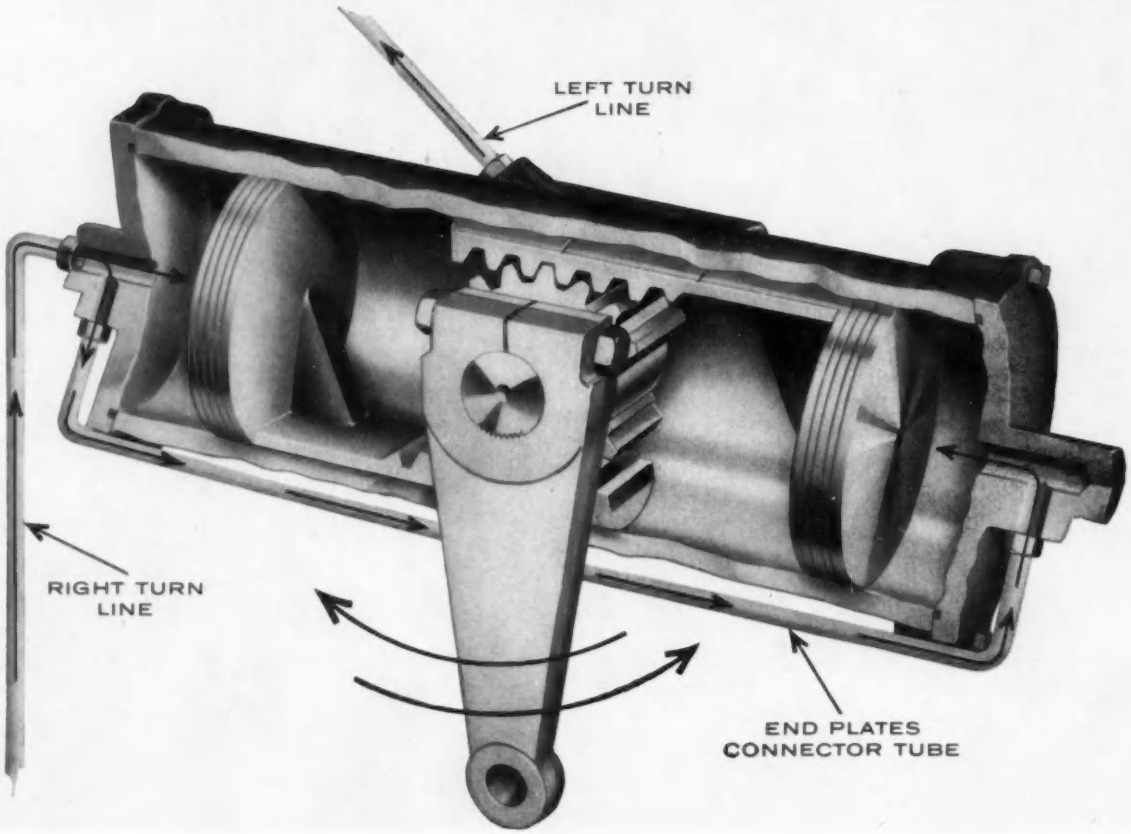


This design is entirely different from ordinary V-type packing. CHEVRON has an exclusive construction which assures the automatic action for which it is designed. Also permits the use of less packing in shallower stuffing boxes.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

*Registered Trademark.



Now...a new kind of Power Cylinder to help you cut costs

THE new rotary motion Thompson Power Cylinder provides versatility of application, ease of installation, compactness and efficiency certain to solve many design and manufacturing problems. These features can cut your costs by simplifying production. It is now in use in a leading make of heavy-duty trucks.

Requiring a minimum of space, the Thompson Power Cylinder can be operated wherever hydraulic or pneumatic pressure is available. Operating from 600-1000 psi, at 700 psi it delivers approximately 26,000 inch pounds torque output. These parameters can be varied to obtain a custom installation. Also, over-running clutches, sprockets, gears, chains, etc., are easily adapted to the output shaft to further increase its versatility.

Precision engineered, the Thompson Power Cylinder is as dependable as it is versatile. You can count on a long, continuous, trouble-free life.

To learn more how the Thompson Power Cylinder can save you money in design, manufacture and installation costs, write for our free booklet. Described are many of its diverse uses and additional benefits. Mail to Thompson Products, Inc., Michigan Division, 34201 Van Dyke Avenue, Warren, Michigan.

You can count on

Thompson Products

Michigan Division:

Warren and Portland

to a temperature in the plastic range and subjecting the structure to a hot forging operation.

Many advantages can accrue to designers and users of this forging technique. The principal ones are:

1. Reduction in weight in dynamically stressed wrought steel assemblies.
2. Increase in design factor values.
3. Reduction in the amount of expensive machining.
4. Conservation of critical alloying materials.
5. Opportunity to produce integrally forged geometric shapes hitherto impossible by conventional forging methods.
6. Enhancement of mechanical properties and microstructure of the forged weld, compared to the unforged weld section, so great that the forged welded section exhibits properties comparable to the parent forged material.
7. In certain forging operations subsequent to welding, it is possible to exclude a percentage of the weld material from the finished forged part.
8. Integrally forged metals of varying compositions such as carbon steel and SAE 4340 can be used, as well as combinations of stainless steel.
9. Permits production of forgings hitherto impossible due to limitations in size of raw material.
10. Weld material with a chemical composition identical to the parent material can be deposited. This was prohibitive hitherto, due to elongation values substantially lower than parent metal.

To Order Paper No. 129 . . . on which this article is based, see p. 5

Earthmoving Progress Cuts Highway Maintenance

Based on paper by

H. A. RADZIKOWSKI
U.S. Bureau of Public Roads

BECAUSE earthmoving costs haven't advanced as fast as other construction costs in the last 30 years, our living standards are higher than otherwise they would have been. Earthmoving costs have, in fact, gone down since the mid-'20s, if measured in terms of constant dollar value.

Earthmoving equipment has exerted a most favorable effect on highway construction costs by making it possible to:

1. Build in design features during construction which reduce maintenance effort.
2. Use modern earthmoving and ma-

Continued on page 126

terials handling equipment in maintenance operations.

With costs relatively stabilized, winding contour alignment and rolling profile no longer need to be followed to balance earthwork quantities and thereby reduce grading costs. Adequate sight distances and other desirable safety features can now be built in without prohibitive costs.

Tangible effects from the resulting favorable costs include the flattening of cut and fill slopes to reduce erosion, promote vegetation, and facilitate mechanical mowing operations. Roadsides with slopes that can accommodate power mowers can be mowed for at least one-quarter the cost of hand mowing.

Raising grade lines above the adjoining topography and streamlining side slopes to prevent accumulation of drift snow is another boon to maintenance effort. The average annual cost of snow control and removal on highways incorporating these new features is very much lower. A recent statewide survey, for instance, reveals that proper embankment and cross-section treatment could reduce these removal costs from $220 to $11 per mile.

Mechanization has enabled highway departments to cope with a constant increase in traffic and the greater frequency of heavy axle loads. In the last decade maintenance cost per 1000 vehicle miles has been reduced from $4.42 to $3.02, a reduction of 32%.

To Order Paper No. 176 . . . on which this article is based, see p. 5

Dry-Type Air Cleaners Vie with Oil-Bath Type

Based on paper by

H. M. TURNER
Donaldson Co., Inc.

THE disagreeable task of cleaning an oil-bath air cleaner and the problem of possible oil carry-over both helped to stimulate development of the dry-type air cleaner.

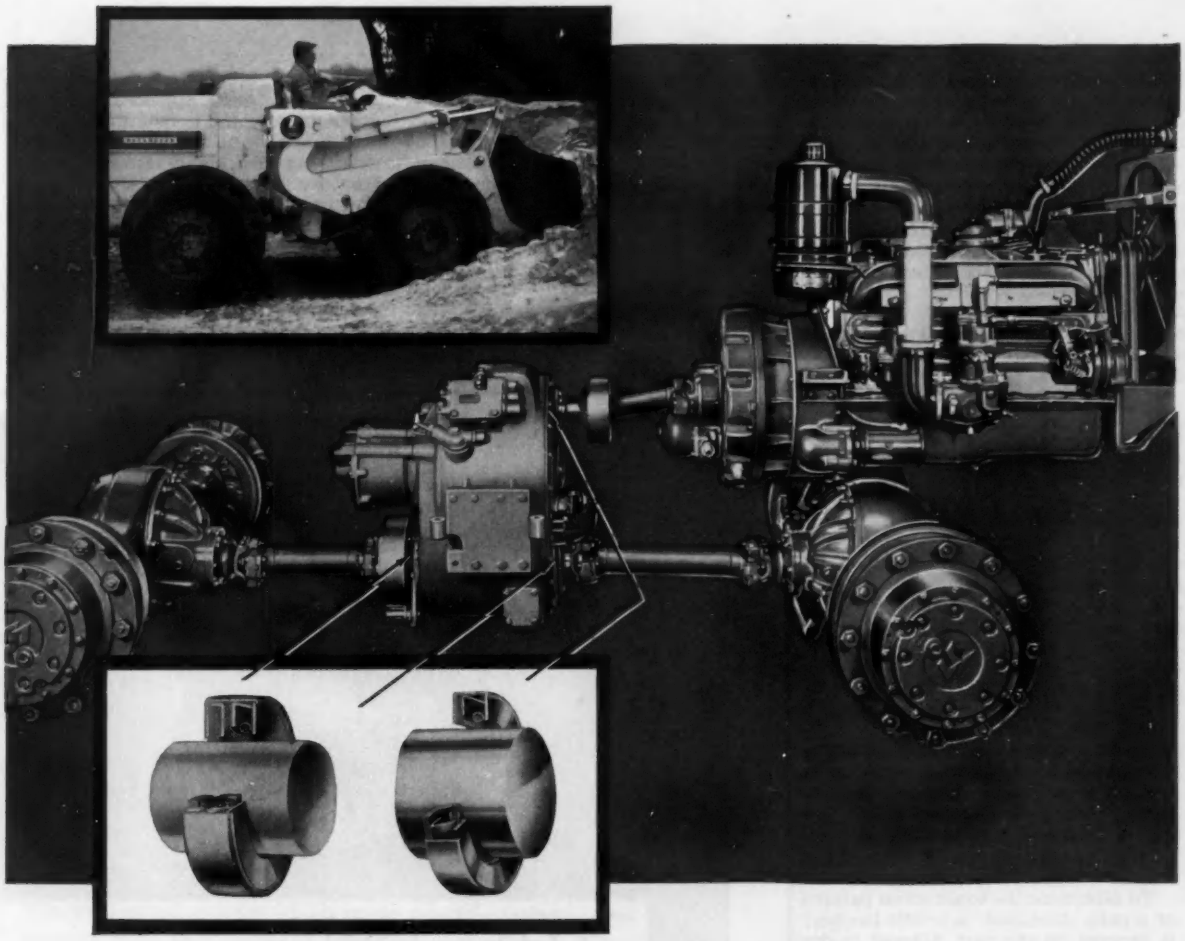
In practical size, the paper cartridge type of air cleaner for medium and heavy-duty operation has an inherent low dust holding capacity. Necessary design limitations and the need for frequent service require the giving of special attention to prevent paper rupture and gasket leaks. Frequent cartridge removal for service exposes a direct opening into the clean air side of the air cleaner. This is serious because the dry dust may be dislodged and fall into the clean air chamber. The design of the cleaner and installation position can minimize this problem.

A serious problem is the pickup of contaminants other than dust such as oil, soot, smoke, and carbon. These materials can decrease service life to almost zero. Over-highway trucks normally operating 50,000 miles without cartridge service cannot operate 1000 miles in such a contaminated atmosphere. Careful attention to installation and inlet location will help. The inlet must not pick up exhaust and breather fumes.

The high cost of paper cartridges leads to efforts to clean and re-use them. In the process the material can be ruptured without detection, creating a direct leak to the engine. Rapping and reverse flow of compressed air are satisfactory methods of cleaning these units at times. However, oil and soot cannot be removed in this manner. Carbon tetrachloride or detergent solutions have been used with some success for the removal of these contaminants.

Of the four types of air cleaners available—the oil-bath and the three types of dry-type cleaners (paper cartridge primary unit; paper cartridge unit secondary to an oil bath; composite dry with a primary cyclone separator and a paper cartridge secondary) —the composite dry unit has the lowest service cost. The efficiency of the pri-

Continued on page 128



Keeps a workhorse working!

C/R lifeguards the power-shifted transmission in the big Hough "Payloader"

The new Hough Model HH "Payloader" is a big, tough tractor-shovel that wades through hard, rugged work day after day without flinching. Its power-shifted transmission makes it one of the fastest-maneuvering, easiest-handling tractor-shovels on rubber. To keep the transmission humming, two shafts must be protected: an input shaft turning up to 2,200 r.p.m., and an output shaft operating at speeds up to 3,000 r.p.m. All vital parts of the transmission are pressure-lubricated—the SAE 10 HD oil *must* be retained; dirt and grit *must* be excluded. C/R Type P and F Oil Seals with the Conpor K-400 sealing elements . . . specified by Hough engineers . . . have been performing with complete dependability well beyond the required 2,000-hour service life.

If you have similar problems involving lubricant retention or dirt exclusion, C/R Oil Seal engineers can help you. They'll select the correct seal for your application or gladly cooperate with you on special designs.

More automobiles, farm and industrial machines rely on C/R Oil Seals than on any similar sealing device.

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mary cyclone separator is as high as many of the oil-bath units, providing an adequate factor of safety should the secondary paper cartridge or its seals fail. Its superior performance will more than justify the slight added space and the additional cost.

To Order Paper No. 167 . . .
on which this article is based, see p. 5

Analyzing Tractor Design for Stresses

Based on papers by

D. J. WARD
Allis-Chalmers Mfg. Co.

and

L. A. GROTTO
International Harvester Co

TO use as little material as possible in a part and to distribute it so as to make the product withstand the severest working conditions makes the use of stresscoat and strain gages absolutely essential in the development of tractor design.

To determine the exact stress pattern of a part, stresscoat (a brittle lacquer) is sprayed on the part, allowed to dry for several hours, then the load is applied and the part examined. The stresscoat will crack at points of high tensile strain, the cracks running at right angles to the direction of the strain. Selection of the particular lacquer from the series available depends upon the temperature and humidity at the test area and the strain at which cracking is desired. In general, the range of cracking can be controlled to start at 500 up to 1500 microin. per in., corresponding to 15,000 to 45,000 psi stress in steel.

The stresscoat patterns indicate the tensile strains in that area of the structure to be equal to, or greater than, the strain sensitivity of the coating. Since the nature and magnitude of loads on the parts of the structure are difficult to determine and even more difficult to control, strain gages must be used to compliment the stresscoat results. Thus, the stresscoat is used only as a preliminary test to locate highly stressed areas, and to determine the direction of the maximum principal strains in the highly stressed areas. This test acts as the blueprint from which strain gages are located so that quantitative values of strain can be obtained.

Illustrative of the precision with which stresscoat tests can locate the critical areas for strain gage application is the tractor main frame shown in Fig. 1 which failed during a severe

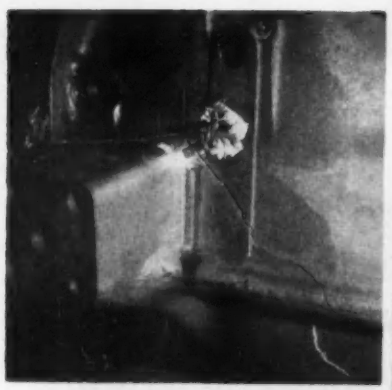

Fig. 1—Outside of tractor main frame showing failure running through strain gages. Location of strain gages was determined by preliminary stresscoat test.

field test. Note how the failure passed through the strain gages.

Where the stress field is complicated, or the value of the shear stress is desired, knowing the direction of the maximum principal strain is important. This knowledge makes possible a complete description of the stress field with only two strain gages, or a determination of the maximum principal stress with only one gage. If the direction of the maximum principal strain were not known, this information could be obtained only by using strain gage rosettes consisting of at least three strain gages. The importance of this in field tests is obvious, since the number of strain gage recording channels available is usually limited.

Value of Recordings

A field test is, in essence, a dynamic test, hence instruments are needed to record the strain gage readings. Instrumentation generally consists of a power supply, a balancing and calibrating unit, and a recording unit. The recorder can be of the direct writing type, or of the type where is reflected from a galvanometer onto photographic paper. The recordings give values of working stresses from the various operating conditions.

Both the maximum and minimum strain values are important as are their number of cycles during the loading. The test data are plotted on the Goodman diagram for the material and the prediction can be made at once if a fatigue stress cycle is present. If such a cycle is present, the data obtained make possible an estimation of the life of the structure under the various working conditions.

The importance of these data is obvious when it is realized that probably 85% and more of field failures of tractors and their allied equipment are of a fatigue nature.

The measurement of loads in the field is just as important as the measurement of stresses. With working loads known, the basic structure can be designed satisfactorily with the minimum safety factor. When strain gages are used to measure loads they are applied in a manner to sense only the desired type of load. Applications can be made to indicate only bending, tension, or torsion. From these basic applications, devices known as transducers can be made to measure almost any load

To Order Papers Nos. 184 and 185 on which this article is based, see p. 5

Two Aids Pinpoint Excessive Exhaust Smoke

Based on paper by

F. W. BOWDITCH

General Motors Research Staff and Chairman, AMA Special Group on Exhaust Smoke

A PROGRAM for recognizing unnecessary vehicle-exhaust-smoke emissions has been set up by a Special Group on Exhaust Smoke of the Automobile Manufacturers Association. An educational film acquaints law enforcement personnel with the smoke-emission problem and a small pocket guide acts as a yardstick in judging unnecessary exhaust smoke.

The training film shows, in color, typical exhaust-smoke emissions from the most common vehicle types, indicates broadly which emissions are bad, and points out misleading conditions during which vehicles may appear to have excessive emission.

The film narative explains that unnecessary visible emissions from gasoline-powered vehicles are usually caused by excessive oil consumption re-

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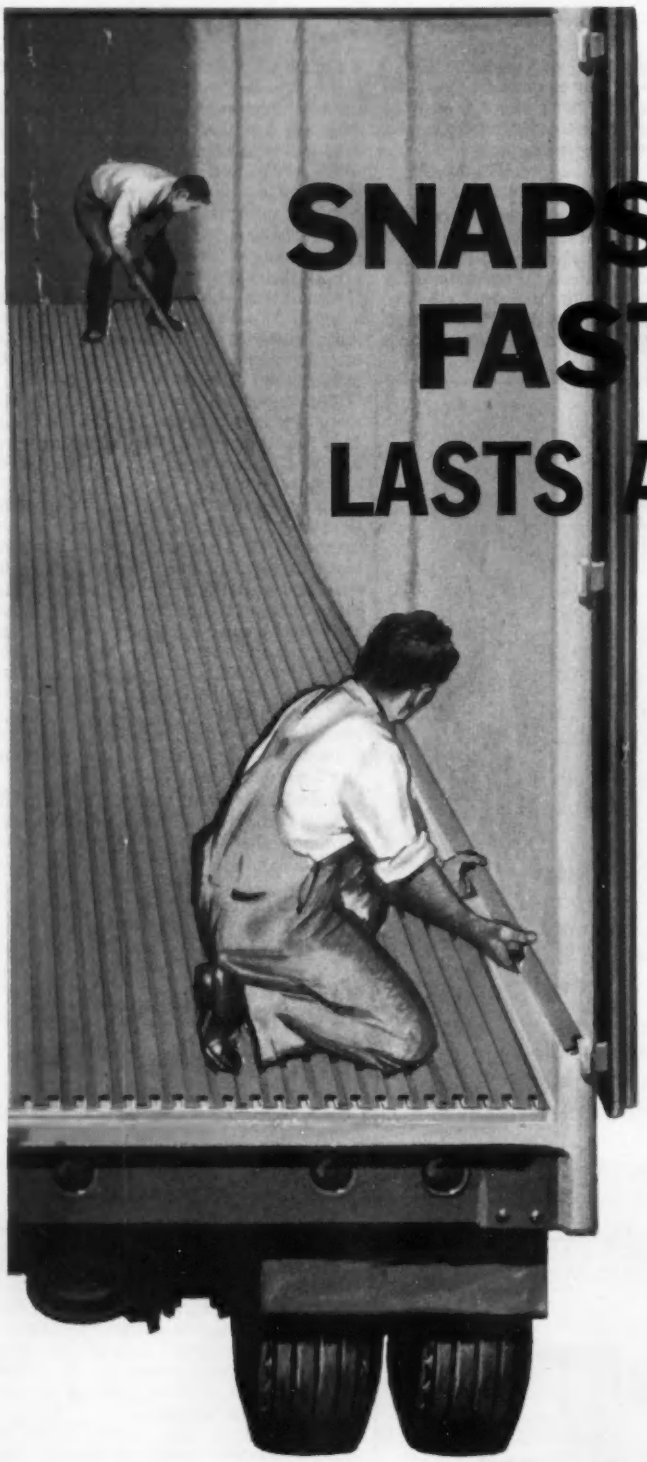
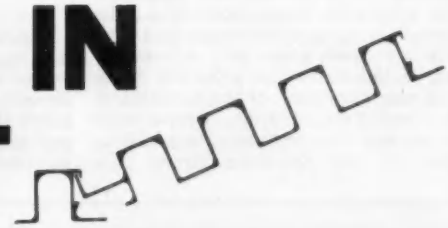
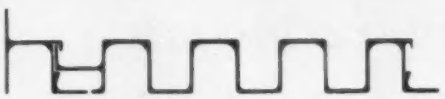


SNAPS IN FAST LASTS A LIFETIME!





BRIDGEPORT ALUMINUM "SNAP-IN" REEFER FLOOR

It's unique—Bridgeport's new design in reefer floors. Easy-to-install, individual extruded sections lock together, form a permanent, flat, weathertight floor, even in 30- to 35-foot assemblies. No boltholes through floor. Hours of installation time are saved—payloads are bigger because of weight savings—and maintenance costs go down, because of the long-life qualities of corrosion-resistant aluminum.

"Snap-in" floor sections are one of many designs in Bridgeport's complete line of standard aluminum truck and trailer shapes available without die charge. All are designed and extruded with the high standards and exact needs of the truck and trailer industry in mind. Custom-designed shapes, too, in any temper or alloy, can be made by Bridgeport to meet your specifications. Your nearby Bridgeport Sales Office is ready to serve you. Call today.

Write on your letterhead for Bridgeport's new Aluminum Extrusions Handbook—a 130-page manual with complete sections on truck and trailer construction, full size shapes available, data, limits and tolerances.

For the very newest in

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Bridgeport Brass Company, Aluminum Division, Bridgeport 2, Connecticut • Offices in Principal Cities

sulting from worn piston rings, cylinder liners, and valve guides.

Similar emissions from diesel engines generally result from overfueling that may be caused by incorrect injector adjustment or burned injector tips, restrictions in the inlet air system, overloading the engine, substandard fuel, cold operation, or mechanical deterioration of the engine.

Misleading conditions, such as the emission of water vapor during cold operation, and the formulation of dust clouds resembling exhaust emission are also illustrated in the film.

To identify vehicles that are smoking unnecessarily, a small pocket guide was developed. The guide contains a single color photograph of each of the common type vehicles and shows for each what was felt representative of marginally unnecessary exhaust emission.

For a given vehicle type, if smoke emission is equal to or greater than that shown in the appropriate photograph, it is considered unnecessary.

The Detroit Police Department is currently using both the training film and the pocket guide in enforcing the vehicle-exhaust-smoke ordinance.

To Order Paper No. 172 . . .
on which this article is based, see p. 5

New R. R. Car Worth May Be Overestimated

Based on paper by

RANDON FERGUSON

Association of American Railroads

RAILROAD ride comfort on curves is affected by the design of both track and equipment. The track design involves the factors of permissible speed, outer rail elevation, curvature, and length of spiral. The equipment factors are found primarily in the design of truck springs, swing hangers, damping action, and other truck stabilizers.

Action of the new light-weight, low center of gravity cars on curves has been somewhat misconceived and misrepresented. Lowering of the c.g. of the car does not change that of the passenger, and a given lateral acceleration will affect him as much as in a standard car. The low c.g. car will probably have somewhat less roll which will be an improvement as far as riding comfort is concerned, but even if this roll is completely eliminated only about 15% increase in speed can be had for the same comfort limitation. The stability against overturning will be better, but this is not a limiting factor in passenger equipment. The overturning speed is much beyond the comfort limit and railway equipment will generally "climb" over the rail due to

Continued on page 132

lateral flange pressure and friction before the car will overturn if the track is reasonably strong.

One design of car has a modified type of pendulum suspension which could increase comfortable speed if the car can roll inwardly instead of outwardly in the manner of a bicycle. But if the inward roll is too large, clearance problems arise.

To Order Paper No. 137 . . . on which this article is based, see p. 5

5 Ways to Improve Tractor Maintenance

Based on paper by

J. A. WEBER
University of Illinois

TO improve the general level of farm tractor care, each maintenance item must be analyzed separately. Consider the care the item now receives, the resulting condition of the item in the field, the difficulty of the chore, and present manual recommendations. Better all-over maintenance could be had by following one or more of the following five suggestions:

1. Eliminate as many maintenance chores as possible by basic design. One manufacturer, for example, has incorporated the crankcase breather with the air cleaner and so eliminated one maintenance chore. To follow all manual recommendations to the letter would require an equivalent of 10% of the operating time, or about 60 hr per year. Actually, about one-half this time is being spent, therefore, any reduction in required time would improve care.

2. Design tractors for easy, quick maintenance chores when they cannot be eliminated. A battery that's accessible and serviceable without a wrench will get better care than one hard to service. "Streamline" design often sacrifices ease of maintenance.

3. Examine every recommendation to see if time intervals are realistic. For example, the common recommendation for daily cleaning of air cleaners would be more realistic if it were called daily inspection. Cleaning should be based on a certain level of dirt in the cup or change in oil condition. When recommendations are unrealistic, farmers set up their own haphazard schedules.

4. Standardize recommendations and improve the general level of manuals. A study of 10 models of 60 tractors revealed a wide variety of recommended intervals; some manuals contained

Continued on page 134

hoover locks lube in, dirt out for the lifetime of the bearing

Hoover is first to seal ball bearings with TEFLON! Hoover makes *sure* that lube stays in, dirt stays away from the smooth, mirror-like working surfaces of high quality *Micro-Velvet* Lapped Balls and *Hoover Honed* Raceways. You get greatly extended bearing life.

Why TEFLON for seals? TEFLON is the remarkable new product of chemistry . . . extra tough . . . extra long wearing . . . and so slippery that there is practically no torque resistance. Hoover seals are ingeniously engineered to maintain positive contact and improve lube circulation. Permanently attached full metal shields lock the seals within the bearing, safe from damage.

Use Hoover Ball Bearings with single or double seals of TEFLON for high speed applications, electric motors, or wherever periodic lubrication or maintenance is not practical, as in sealed units. They are available in both light and medium series.

*TEFLON is DuPont's Trademark for its Fluorocarbon Resins.
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SAE-14

conflicting recommendations when the service interval was listed in two or more places. The intervals for the 10 manuals included 10, 30, 40, 50, 60, 100, 120, and 125 hr. One manual had chores specified for 10, 60, 100, 120, 250, 300, 400, 500, and 1000 hr, intervals. Imagine the bookkeeping required to maintain such a schedule.

Operators in this study did not follow recommendations closely enough to justify so many intervals. The difference between 250 and 300, or between 300 and 400 hr is unrecognized. Better care would result if the number of intervals were minimized and made multiples of time for oil change. A simplified schedule might include intervals of 10, 50, 100, 200, and 400 hr. For example, at 200 hr the operator could do all the chores for 200, 100, 50 and 10 hr. Simplification of intervals would make farmer education easier and would serve as a guide to component manufacturers.

The SAE CIMTC Subcommittee XVI on ease of maintenance has made great progress in standardizing maintenance intervals and working toward simplification of the care of bulldozers, cranes, and other heavy equipment. It is to be hoped that similar activities can be initiated for farm tractors as a joint project of the Farm Equipment Institute, American Society of Agricultural Engineers, and the SAE.

5. Keep on working to educate the farmer on tractor maintenance. Recommendations are not enough. He needs to know "why" as well as "how" and "when."

To Order Paper No. 181 . . . on which this article is based, see p. 5

Laws Make Movement Of Cranes Too Costly

Based on paper by

QUINCY J. WINSOR

Thew Shovel Co.

MOVING a crane is an expensive operation in some states, due to permits, license for the carrier or chassis weight, and special license or regulations. Efforts to reduce this cost in a single state meet with success now and then, but it would be desirable if it could be done everywhere so that a crane standard could be promoted.

One approach seems to be to tow a trailer and make the unit a combination vehicle with higher total weight allowance and longer length. But this introduces another factor. When a tractor is made out of a crane, the insurance characteristics are changed, making it subject to automobile policies on the highway and possibly making it a commercial vehicle towing a load.

Another approach is to win recognition of the greater load carrying ability of the 4-axle carrier.

Sample moment and shear diagrams have been made for bridge loadings on spans of 40 ft and longer to see how the American Association of State Highway Officials Standard Bridge Loadings for 3-axle single vehicle and the combination tractor-trailers compare with a 4-axle crane carrying 18,000–20,000 lb on the forward bogie. These diagrams show that the 4-axle vehicle with legal loadings considerably in excess of the legal single vehicle or table allowance is no worse than the far heavier combination vehicle legal loadings. The table of weights and extreme axle spacing does not properly recognize this condition.

A concerted effort should be made by crane manufacturers and users to develop a more acceptable weight allowance for 4-axle vehicles and a

Continued on page 136

STAINLESS STEEL MAKES THE DIFFERENCE

...its effect on car sales and resales

Nothing sells and satisfies like quality. Stainless steel provides proof of quality in a way the buying public can *easily* understand.

Consumers know from experience that stainless steel means rust resistance . . . strength . . . freedom from scratches and dents. They *know* it stays bright without polishing.

That's why stainless steel carries so much selling power in the showroom and even more on the used car lot.

For more facts about stainless steel see your supplier or write: ELECTRO METALLURGICAL COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

METALS DO MORE ALL THE TIME ...THANKS TO ALLOYS

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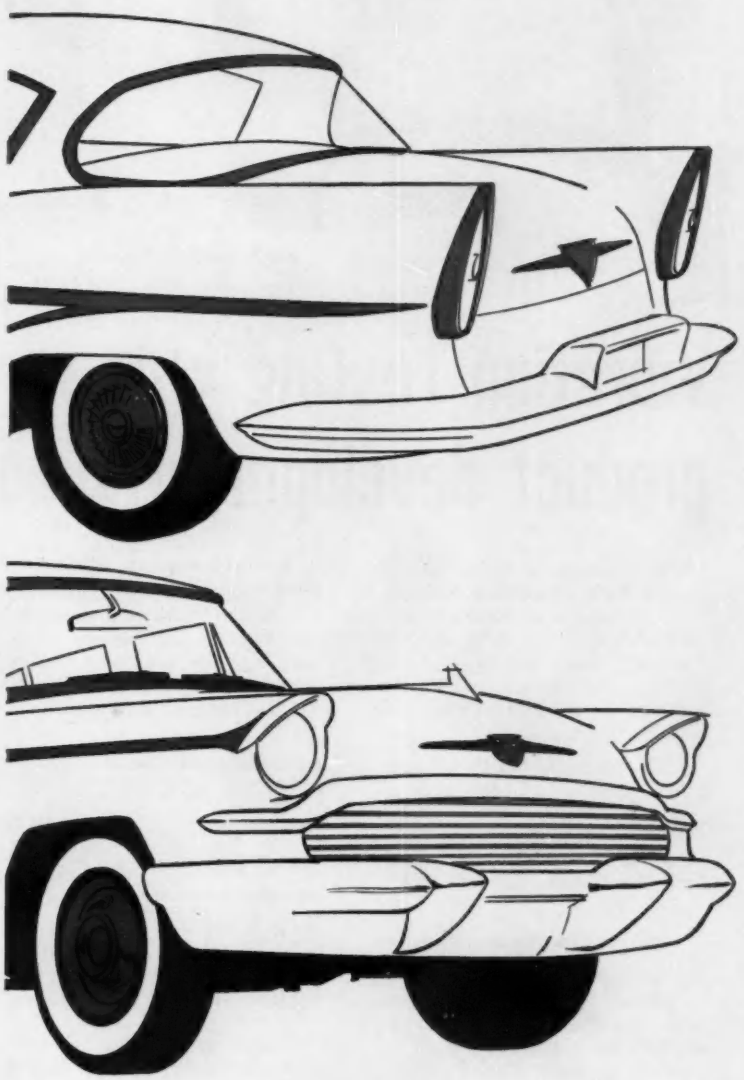

Stainless steel styling is easiest of all to sell! Body and window mouldings, wheel covers, grilles, door handles and even roofs are stainless steel this year!

The terms "Electromet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

longer practical length allowance for the boom overhang to eliminate need of breaking or removing 40-ft booms carried forward. We could then try to obtain recognition of such allowances for mobile cranes. The question of towed loads could be considered at the same time.

Under the Federal Highway Act of 1956 the Secretary of Commerce was directed to expedite a series of tests now planned or being conducted by the Highway Research Board on maximum desirable dimensions and weights, and to report findings and recommendations to Congress not later than March 1, 1959. It will be interesting to keep an eye on the progress of this study.

To Order Paper No. 179 . . . on which this article is based, see p. 5

New 3-Point Hitch Standards Proposed

Based on report by

R. J. MILLER

chairman, Three-Point Hitch Subcommittee, Advisory Engineering Committee, Farm Equipment Institute

A Three-point Hitch Subcommittee was established to consider standards as a recommended practice for 3-point hitches that would be more satisfactory than the existing British Standard. It was to consider the functional performance of the hitch and the hitch-to-power-take-off relationships as well as standardize on the sizes of hitch pins, and such. The British Standard was used as a starting point for establishing a proposed American Standard.

One of the first activities of the subcommittee was to establish a nomenclature so that all dimensions would be tied down to a common language. A definition of terms was proposed and established.

Then, dimensions were divided into two categories:

Category 1—Hitch dimensions intended for tractors having a work capacity up to 3500-lb maximum drawbar pull, based on SAE-ASAE agricultural tractor test code, Test F.

Category 2—Hitch dimensions intended for tractors having a work capacity over 3500 - lb drawbar pull, based on SAE - ASAE agricultural tractor test code, Test F.

As the result of a survey of current manufacturers of 3-point-hitch tractors and implements, data was compiled which enabled proposing some standards. However, some dimensions, primarily mast height and lower hitch point to tractor clearance, have not as yet been definitely established.

To Order Paper No. 190 . . . on which this article is based, see p. 5

XXIII

This is the twenty-third of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Annealing: Its Uses with Alloy Steels

Broadly speaking, the primary purpose of annealing is to soften steel and make it more workable. Annealing, as applied to alloy steels, may be defined as a process that heats above, and furnace-cools through, the critical range at a controlled, specified rate of speed; or that heats to a point within, and furnace-cools to a point below, the critical range. In either case, the choice depends upon the structure and maximum hardness desired.

The first method produces a lamellar pearlitic structure, while the second creates a spheroidized condition. These will be discussed separately in the following paragraphs:

(1) *Lamellar pearlitic structure.* It should be mentioned at once that this structure can be obtained both as described above and by a modified method known as isothermal annealing. In the isothermal process, the steel is heated above the critical temperature (austenitized), then transformed at a predetermined temperature, which depends upon the analysis. This operation requires two furnaces or salt baths —one for austenitizing, one for transformation.

Lamellar pearlitic structures are generally associated with machinability in carbon ranges from 0.20 to 0.60 pct, provided the hardness does not exceed the optimum maximum Brinell numeral. This is especially true where critical tooling is involved. It is a very versatile structure, as it gives best results in such operations as broaching, tapping, threading, deep drilling, boring, milling, and tooling as applied on single- and multiple-spindle bar automatic machines.

(2) *Spheroidized structure.* There are two general fields of use for this type of structure when alloy steels are employed. In the low and medium carbon ranges, spheroidization is necessary for cold-shaping operations, such as heading, extruding, drawing. In the higher carbon ranges (over 0.60 pct), it is mandatory where machining is involved, because it tends to lower the hardness of the steel.

As noted elsewhere in this discussion, both lamellar pearlitic and spheroidized structures can be created through annealing. If you care for more details about these and other uses of annealing, and the results to be expected, by all means consult with our technical staff. Bethlehem metallurgists will gladly help you work out any problems. And when you are ready for new supplies of alloy steels, Bethlehem can offer the full range of AISI standard grades, as well as special-analysis steels and all carbon grades.

If you would like reprints of this series of advertisements from No. I through No. XX, please write to us, addressing your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa. The first 20 subjects in the series are now available in a handy 36-page booklet, and we shall be glad to send you a free copy.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

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New Members Qualified

These applicants qualified for admission to the Society between August 10, 1957 and September 10, 1957. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

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Baltimore Section

W. F. Whitesides (M).

British Columbia Section

Harold F. M. Robinson (A), Ronald Blair Thicke (M).

Canadian Section

Lloyd S. Bergen (A), John Stuart Bright (M), F. W. Clayton (M), D. V. Dickie (A), William B. Flora (A), Harry John Graham (A), O. John Krohn (M), J. George Slubicki (M).

Central Illinois Section

Eugene L. Caldwell (A), George H. Nelson (A), William J. O'Shaughnessy (J), Robert N. Stedman (J), J. Arthur Weber (M).

Chicago Section

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Cincinnati Section

Eugene Gatewood (A), Cecil J. Goldthorpe (A), Jerome Rich (A).

Cleveland Section

James A. Creedon (M), John G. Harmath (A), John T. Simone (A).

Dayton Section

Charles Edward Lloyd (M).

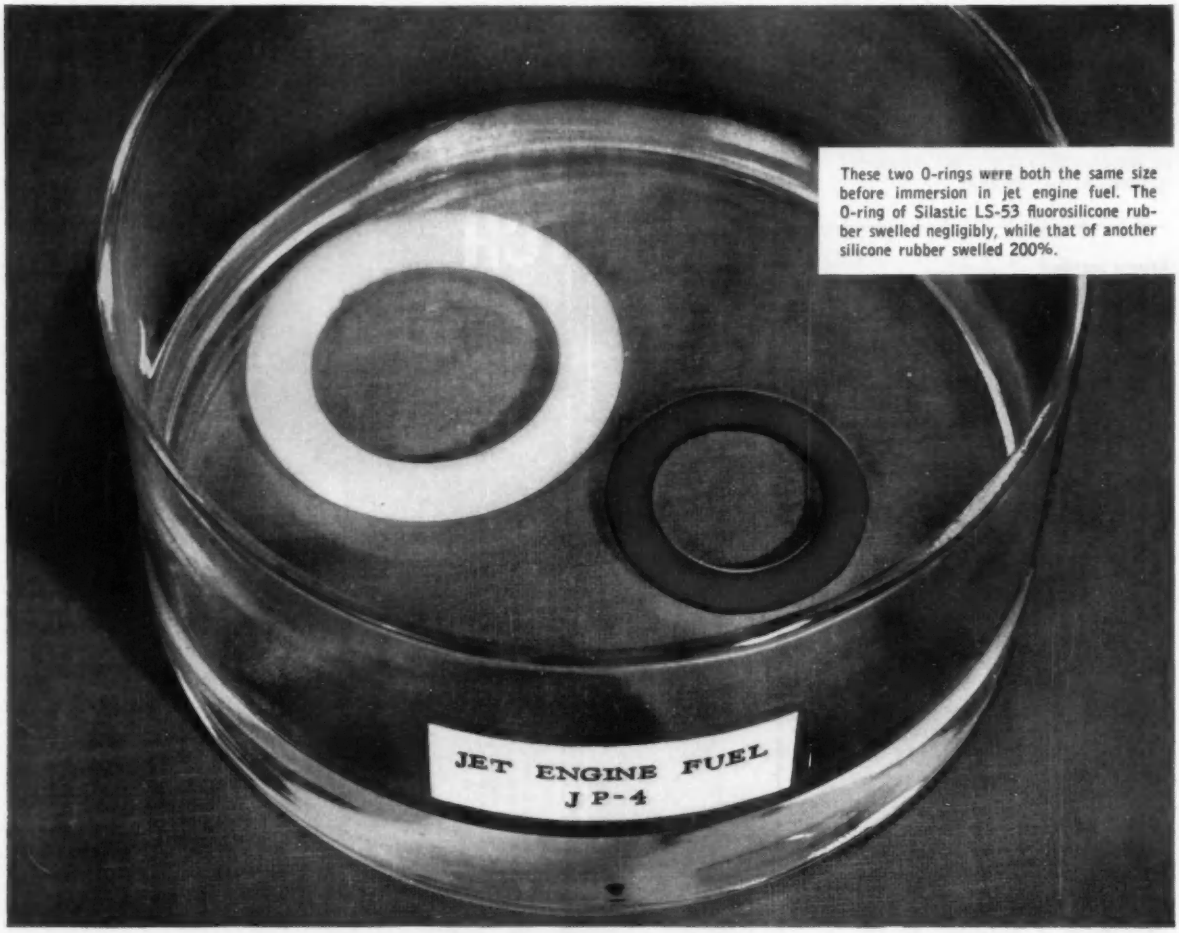
Detroit Section

Marion H. Antonini (J), Howard A. Aula (M), Tom K. Barton (M), Charles D. Branigin (M), William Cholewka (M), Gerald F. Fox (J), William T. Homan, Jr. (M), Robert A. Husen (J), Stanley William King (A), Leslie S. Kobylinski (M), Wilbur C. Nelson (M), Albert C. Nichols (J), Fred Karl Nothdurft (J), Edward R. O'Neill, Jr. (M), Sabatino Sam Petrilli (J), Milton C. Portmann, Jr. (A), Carl D. Rogers (M), William John Schrader (J), Louis P. Smith (A), Ming-Chih Yew (M).

Indiana Section

Don J. Bowling (M), Raymond E. Gill (M), Glenn E. Mather (M), Milton B. Snyder (J), Stanley H. Updike (J).

Continued on page 141



These two O-rings were both the same size before immersion in jet engine fuel. The O-ring of Silastic LS-53 fluorosilicone rubber swelled negligibly, while that of another silicone rubber swelled 200%.

SILASTIC SILICONE RUBBER now resists fuels, oils, solvents

For resistance to fuels, oils and solvents, specify Silastic LS

Aircraft and automotive fuels, oils, and solvents won't deteriorate Silastic* LS-53, a new Dow Corning fluorocarbon silicone rubber. Silastic LS-53 has unusual resistance to other organic chemicals as well as silicone fluids. In physical properties, such as low compression set and serviceability at —80 or 500 F, Silastic LS-53 resembles other silicone rubbers. Available from leading rubber companies.

Get latest data on Silastic. Mail coupon today

Dow Corning Corporation, Dept. 9122
Midland, Michigan
Please send me latest data on Silastic

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

*T.M. REG. U.S. PAT. OFF.

Typical Properties of Silastic LS-53

(cured 24 hours at 300 F)

• Tensile strength, psi	1000
• Elongation, %	170
• Compression set, %, 22 hrs @ 300 F	22
• Brittle Point, °F	—90
• Solvent Resistance, % swelled	
ASTM No. 3 Oil, 21 days @ 300 F	3
Jet Fuel JP4, 15 days @ 250 F	18

If you consider ALL the properties of a silicone rubber, you'll specify SILASTIC

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

New Members Qualified

Continued

Kansas City Section
John A. Wood (M).

Metropolitan Section
George G. Brown (M), Ferguson J. Byars (A), M. F. Fansler (M), Louis E. Gaynor (M), John Daniel Griffin (M), Eugene J. Keenoy, Jr. (M), Pierre Maluski (A), Erik Nelson (M), Russell M. Osborne (M).

Mid-Michigan Section
Harold J. Buehler (M), Otto Andrew Kern (J).

Milwaukee Section
Wallace E. Johnson (J).

Mohawk-Hudson Section
John S. Ippoliti (A), Walter Frederic Venneman (M).

New England Section
Francis L. Bry (A), Charles W. Dixon (A), Donald Lee Paster (M), James M. Stewart (A).

Northern California Section
Joseph F. Atkins, Jr. (M), George R. Cunnington, Jr. (J), Albert Karl Kreag (A), R. D. Larimer (A), George Street (A), Harold B. Uhlig (M), Charles E. Wallick (A).

Northwest Section
Bruce Armstrong Douglas (A), Arthur E. George (M), Allen C. Mark (M).

Oregon Section
Thomas C. Ammons (A).

Philadelphia Section
J. Frank Canfield (M), Norman W. Fesmire (M), Donald H. Milne (A).

Pittsburgh Section
Richard W. Shiffler (M).

Southern California Section
E. M. Armsrtong (M), Charles E. Burns (M), Col. Clifford E. Cole (M), J. F. Culp (M), John W. Peel, Jr. (M).

Southern New England Section
Raymond D. Hart (A), Millard Girard Mayo (M), Thomas J. McIntyre (M), Anthony Andrew Pack (M), Max H. Voigt (M).

Texas Section
Raymond C. Burdick (A), Joe C.

Continued on page 142

New Members Qualified

continued

Forbis (A), Starr L. Pitzer (A).

Texas Gulf Coast Section
C. J. Benefiel (M).

Twin City Section
Arthur Willard Boehm (M), Thiel E. Knoertzer (A), Joseph N. Moses (A).

Virginia Section
Edwin S. Hawkins (A).

Washington Section
Alvin J. Tolbert (M).

Western Michigan Section
Thomas Shannon (M).

Outside of Section Territory
Arthur L. Heffelfinger (A), John Y. McCollister (A), John P. Motrie (M), Steve Urosevich (M).

Foreign
Jean-Hubert Frings (J), Belgium; Bernard Grindrod (M), East Africa; N. N. Narayan Rao (M), India; Carl Gustaf Nystrom (M), Sweden; Charles A. Pickering (M), England; James S. Ross (M), Venezuela.

Applications Received

The applications for membership received between August 10, 1957 and September 10, 1957 are listed below.

Atlanta Section
Robert O. Hallen, Kenneth Dixon Kirkham, John E. Marder.

Baltimore Section
Rene A. Lambert.

British Columbia Section
Edgar P. (Ted) Church, Harry S. Gray.

Buffalo Section
Robert James Caulfield, Heldur Ronald Ratnik, Floyd H. Walters.

Canadian Section
Leo John Cada, Charles Stuart Dempsey, Ted J. Klich, Richard A. Knowlton, Gunder Osberg, J. W. Palframan, W. A. Paterson, Marshall W. Roth, Russell R. Tartaglia, G. Stanley Town, L. F. Whitfield.

Central Illinois Section
Celius Robert Anderson, Donald Henry Connor, John M. Dickerson, Marvin C. Keys, Carlisle S. Morris, Sebald K. Stahl, Robert George Symonds, Bruce C. Tibbetts.

Chicago Section
Barry L. Danner, Robert H. Ebert, John T. Ellis, Jr., Edgar Frederick Fiedler, Jesse B. Fox, Angelo M. Gabriel, Andrew J. Herstel, Scott Fon Hoo, A. Peter Huffmire, Jack E. Maxcy, Edward C. McFadden, Cliff Morris, Robert James Mustari, Trygve S. Neprud, James L. Robertson, Walter H. Schrader, James R. Woodrow.

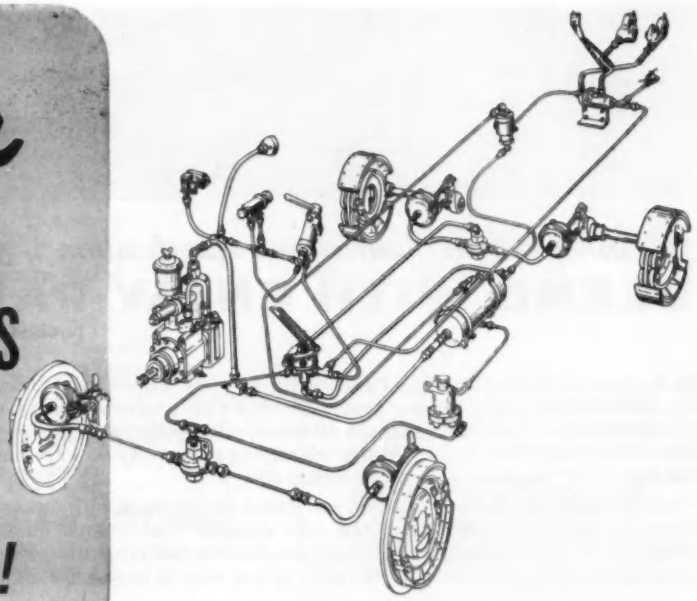
Cincinnati Section
William S. Davidson, Frank J. Rodgers.

Continued on page 145

Wagner

STRAIGHT AIR BRAKE SYSTEMS

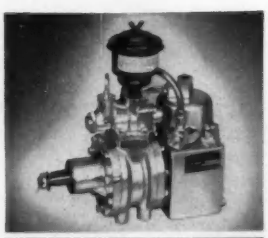
provide safe, sure stops for cam type brakes!

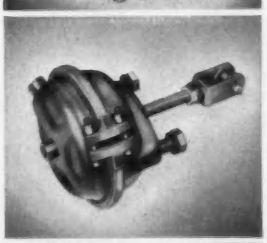


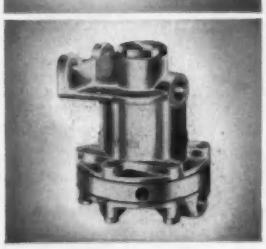
Wagner Straight-Air Brake actuating systems give cam type foundation brakes the ability to make quick, safe stops—completely controlled by the driver. They are furnished plenty of air at all times by the Wagner Rotary Air Compressor. The actuating units and application valves are *positive* in operation—performance-proved on many thousands of installations.

Wagner Air Brakes are the product of more than thirty years of brake engineering experience—gained in the designing and building of brake systems and brake parts for the automotive industry. When you equip the heavy-duty vehicles you manufacture with Wagner Air Brakes, you are adding safety and low-maintenance features that build customer acceptance.

Get all the facts on the Rotary Compressor and other features that make Wagner Straight-Air Systems so dependable and so safe. Write for your free copy of Catalog KU-201—it gives all the facts you should know about Wagner Air Brake Systems.







features include:

WAGNER ROTARY AIR COMPRESSOR — provides an abundance of air at all times. Its cool operation prevents carbon formation in air lines. Uniform torque load and smooth operation with moderate stresses assure long compressor life and long belt life.

WAGNER BRAKE CHAMBERS—have diaphragms of *neoprene* rubber bonded to high-tensile-strength *nylon* fabric for superior oil resistance and maximum strength and flexibility. Available with or without push-rod seal. All brake chamber parts are of corrosion-resistant material, or are plated to prevent rusting. Wagner Brake Chambers are interchangeable with all clamp type and bolt type units equipped with standard mounting studs, regardless of make.

WAGNER MOISTURE EJECTION VALVE—automatically keeps air reservoirs clean and dry by ejecting accumulated moisture with each average brake application—without causing a noticeable drop in tank pressure.

K57-11

Wagner Electric Corporation
6378 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.
(Branches in principal cities in U.S. and in Canada)

LOCKHEED HYDRAULIC BRAKE PARTS and FLUID • HoRoL • CuMaX BRAKE LINING • AIR BRAKES • AIR HORNS • TACHOGRAPHS • ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES

Applications Received

Continued

Cleveland Section

Charles Frederick Aured, Russell Joseph Bouchez, Edward A. Brittenham, Jr., Richard M. Fischer, Thomas Pierre Gardner, Lawrence Gene Gatton, Paul V. Golden, J. Kurt Hill, Robert James Kolodgy, Edward H. Landgren, Robert Hutchins Noble, Paul Rees, Frank Schindler, Herbert P. Schoeck, Jr., William H. Tobener, Richard L. Wann.

Colorado Group

George T. Woods.

Dayton Section

Harold R. Fouss, John Eugene Hodel, Nolan H. Leatherman, Martin A. Rumel, Walter R. Saupe, Richard H. Sommer.

Detroit Section

Robert Charles Anderson, George Arthur Berman, Robert A. Brauburger, C. Kingsley Brown, George S. Cowing, Joseph F. Craig, Richard J. Cumming, Robert O. Dameron, Joseph A. Dankovich, Julian M. Greenebaum, David L. Harbaugh, James F. Haubert, Robert Dale Hissom, Gerald E. Jerome, Lun King Liu, Charles W. Meyka, Ray E. Mick, Donald Wilbur Mold, Andrew Moons, James Michael Morzen, Loring F. Nies, Clarence N. Ohashi, William Keith Ojala, Peter Russell Orlando, John L. Pappin, Robert Ray Parks, Richard E. Rasmussen, Edward J. Russel, George Frederick Schnell, Martin Seitz, Albert S. Sheppard, Herbert D. Smith, Edward J. Snyder, Lloyd J. Stanbery, Ronald J. Swanson, Vincent Swick, Donald Arthur Thornley, Robert Leo Ulrich, Claude T. Williams.

Indiana Section

Norman B. Keith, Gene Rexford Moulton, Jaan Tabur.

Kansas City Section

John R. Colgan, Theodore N. Duncan, David C. Goldberg, Ralph E. Gustafson, William H. Solger.

Metropolitan Section

Frank Whittaker Crook, Hubert Carl Edfors, Patrick J. Heaney, Jr., Simon H. Kahn, George W. Kallmeyer, Kenneth C. Kresge, Eli H. Lesser, Alexander Harold Matz, Jr., Lewis Edwards Minkel, John F. Moult, Jr., Richard F. Neblett, Paul Thomas Olsen, Frank A. Salvatore, Major Robert W. Samuel, Mannie Schneider, Albert M. Sims, Thomas L. Wiegand.

Mid-Michigan Section

John Hamilton Dodge, Ronald Miller, Gilbert E. Shannon, W. Bing Slack, Elvin E. Tuttle.

Milwaukee Section

G. Dean Cannon, John C. Heyvaert, Walter J. Langkau, Norman F. Larson, Walter Michalica, Edward Charles Slagis, Alfred O. W. Wedel.

Montreal Section

Maurice C. Lavigne, Norman Neath, Andrew Novakoff.

New England Section

Francis L. Federhen, Paul Walter Pillsbury.

Northern California Section

Arnold R. Doepel, Percy Elmer Har-

Continued on page 146

Applications Received

continued

mon, Peter L. Marz, John Walter Parks, Arthur Norbert Stodola, Jerome L. Wetterholm.

Northwest Section
Norman E. Arnold, Ralph B. Flaaten, Frank E. G. Grossenbacher.

Oregon Section
Robert B. Gaulke.

Philadelphia Section
Bruce C. Freed, Charles B. Grove, Robert G. Haskell, Lawrence O. Miller, Arthur Thomas Polishuk, Richard Ellis Turner.

Pittsburgh Section
Kenneth R. Feder, Stanley Kmonk.

St. Louis Section
Andrew A. Baumann, Jesse C. Fugate.

Salt Lake Group
Raughn Earl Taylor.

San Diego Section
Ernest A. Bigelow, John F. Brown, Charles Edward Klebert, Larry L. Lynes, James H. Winger.

South Texas Group
Kenneth Brady.

Southern California Section
Leslie LeRoy Allen, Dean O. Baker, Leslie David Conyers, Chester B. Davis, C. Forbes Dewey, Jr., Bert Martin Frey, Joseph Jay Hansen, Joseph A. Hofmann, Jacob E. Jackson, Glenn Milton Laitinen, Donald L. McClure, Kenrick C. Palmer, Irving C. Poling, James J. Rodriguez, W. D. Rothell, Robert W. Rowley, George E. Schaetzel, Sidney R. Shannon, Jr., Marvin Silver, Edwin U. Sowers, III, Richard D. Tobin, Henry A. Traub, Charles Crosby Turner, Jr., Wallace I. Vance, Jr., J. Morgan Watt, Paul D. Whittington.

Southern New England Section
Nelson L. Andrews, Collis Herman Beck, Robert Charles Hover, Albert A. Marchetti, Harold S. Moore, Robert Leonard O'Brien, Bernard L. Schulman, Wilfrid M. Thomson, Robert J. Valentine, Edmond Rich Vianney, Neldon V. Whitty.

Syracuse Section
Richard J. Sutliff.

Texas Section
Jack Ward Myers.

Texas Gulf Coast Section
Mickey Nelson Bonner, Edison D. Jeffus, Capt. James Edwin Light, Jr.

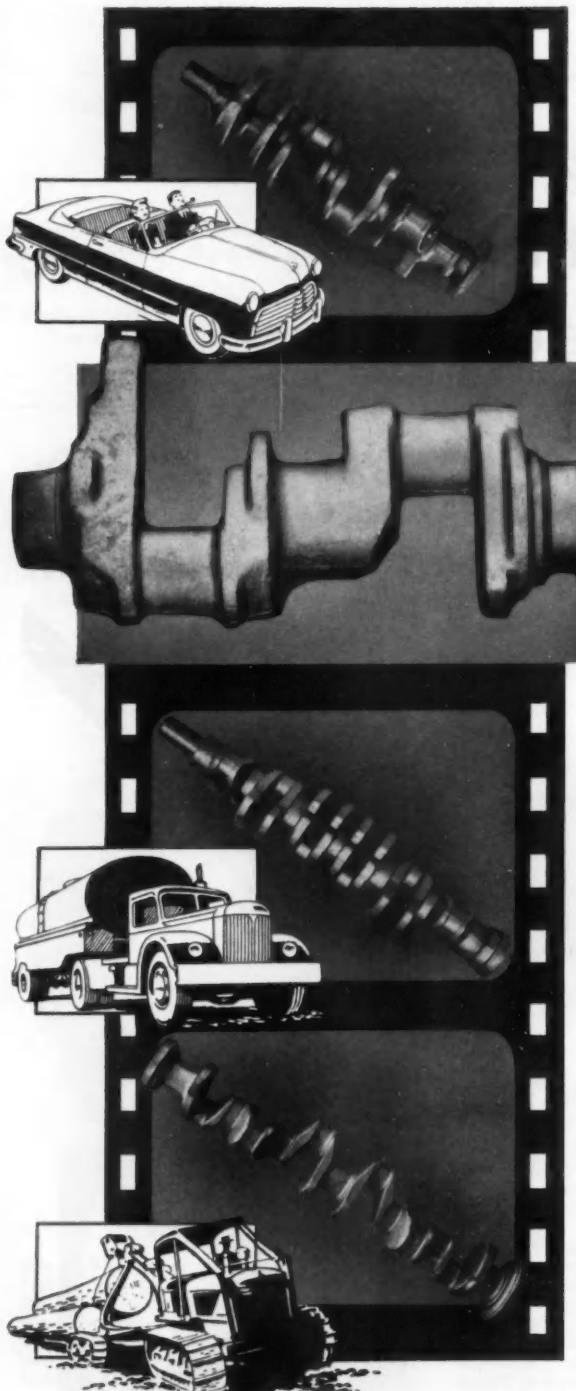
Twin City Section
Kenneth Arne Kujanson, Richard C. St. John.

Virginia Section
Arthur Otto Church.

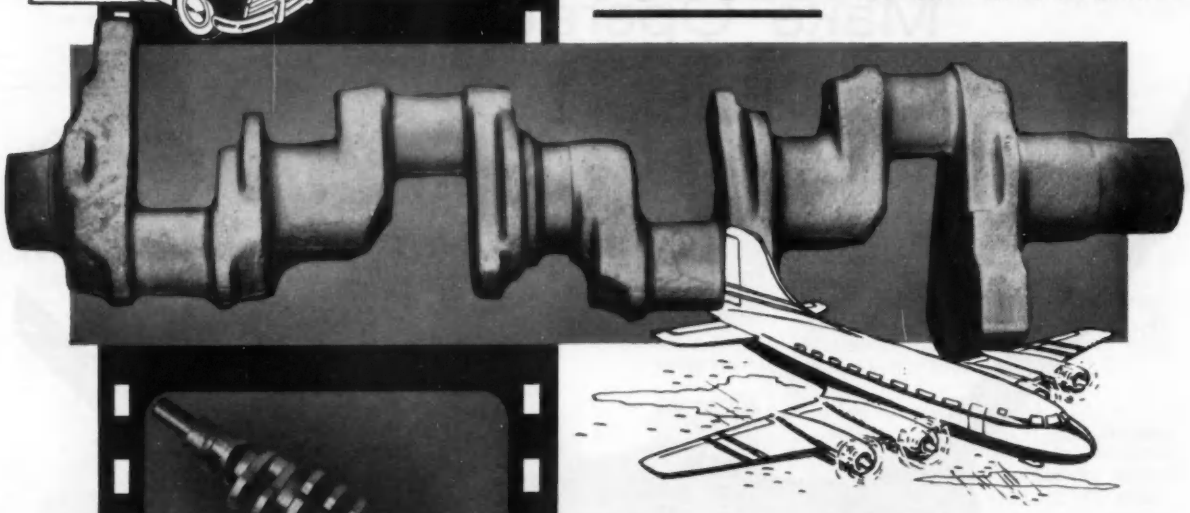
Western Michigan Section
James J. Morrell.

Outside of Section Territory
Wesley D. Campbell, Richard J. Ingalls, Joseph A. Kott, Charles E. LaBelle, Andrew E. Litwin, Robert Earl Prunty, Elwood H. Robinson, Stuart L. Rutz, Edward John Santori, Carl R. Scheuplein.

Foreign
R. Gopal Krishnan, India; John Frederick Moon, England; C. Ramaswami, India; Robert G. Sestier, Mexico; R. Srinivasan, India; Vellanki Venkata Subba Rao, India.



There's no substitute for the FORGED crankshaft



Crankshafts have been made successfully by other methods of fabrication and have proven to be *good enough* for certain non-critical applications—but for maximum dependability of the modern, compact, high compression, high torque engine a forged crankshaft is essential.

The forging process assures, to the greatest degree possible, uniformity and predictability of physical properties with a minimum variance from piece to piece or from one location to another in the same piece.

Wyman-Gordon has been forging crankshafts since the beginning of the internal combustion engine era and today produces more crankshafts for a greater variety of applications than any other company in the world. In a crankshaft there is no substitute for a forging, and in a forging there is no substitute for Wyman-Gordon quality and experience.

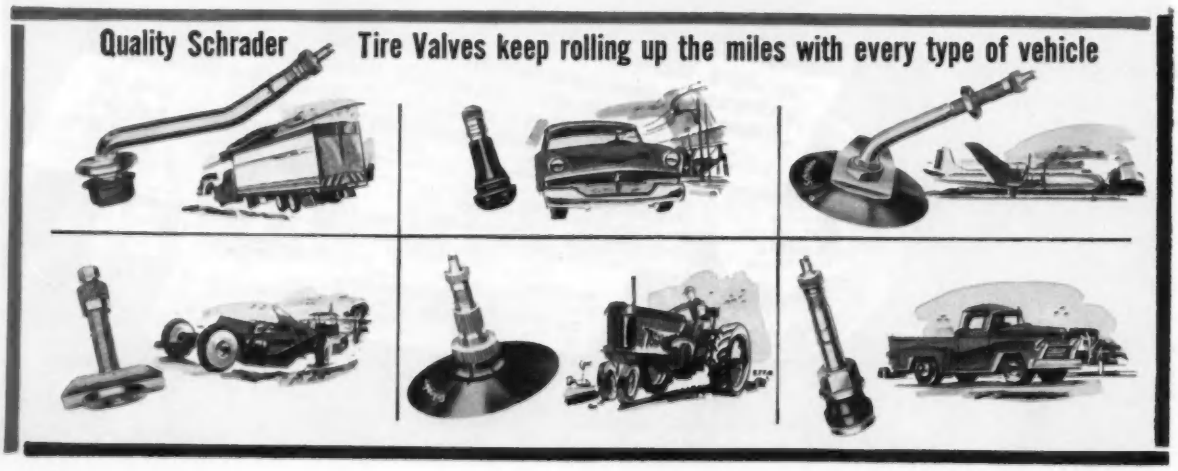
WYMAN-GORDON COMPANY

Established 1883

WORCESTER 1, MASSACHUSETTS
HARVEY, ILLINOIS • DETROIT, MICHIGAN

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

OUTSTANDING TIRE



VALVE PERFORMANCE:

Whose responsibility?

Tire valve responsibility is not just one company's — it's the concern of all the Industry. High tire valve standards are the result of the combined skills and experience of Automotive, Tire and Valve Engineering. Schrader's part is to combine all the Industry information and experience, and produce the safest, most practical valves that different types of pneumatic tires need — now and in the future. That's Schrader's role. You can count on Schrader Valves for the best performance on any or all of your vehicles.

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Division of Scovill Manufacturing Co., Inc.

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FOR ORIGINAL EQUIPMENT AND REPLACEMENT

halos...

for harassed engineers*

Are your leather oil seals or packings giving you headaches instead of halos? Your best cure for this situation – specify IPC.

Why?

Well, because IPC specializes in the custom approach to packings problems . . . leather or synthetic. Better materials and manufacturing techniques add up to better results.

You might be amazed at the applications which are solved by IPC leather packings – plain or impregnated. Ask your IPC representative for a complete rundown . . . *today*.

**Production and maintenance folks, too!*

Packings
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Precision Molding

IPC **INTERNATIONAL PACKINGS** CORPORATION

Bristol, New Hampshire

P5

Spring steel within this range...

FOR THE MOST EXACTING NEEDS KNOWN TODAY!

• That this is the age of specialization is certainly true in the use of steels. And in this regard *Athenia Steel* customers benefit especially by two not-too-common factors. First, by extreme control of quality and uniformity, unsurpassed, seldom equalled *anywhere!* Secondly, by painstaking technical service to determine or develop precisely the right steel for any special need.

Here at Athenia we concentrate on cold rolled high carbon flat steels, custom made of .45 carbon and higher, in widths from .015″ to 16″ and thicknesses from .001″ to .065″. Full range of finishes and tempers. We also produce special narrow width stainless, and the new super-tough, corrosion resistant spring material, Nilcor*.

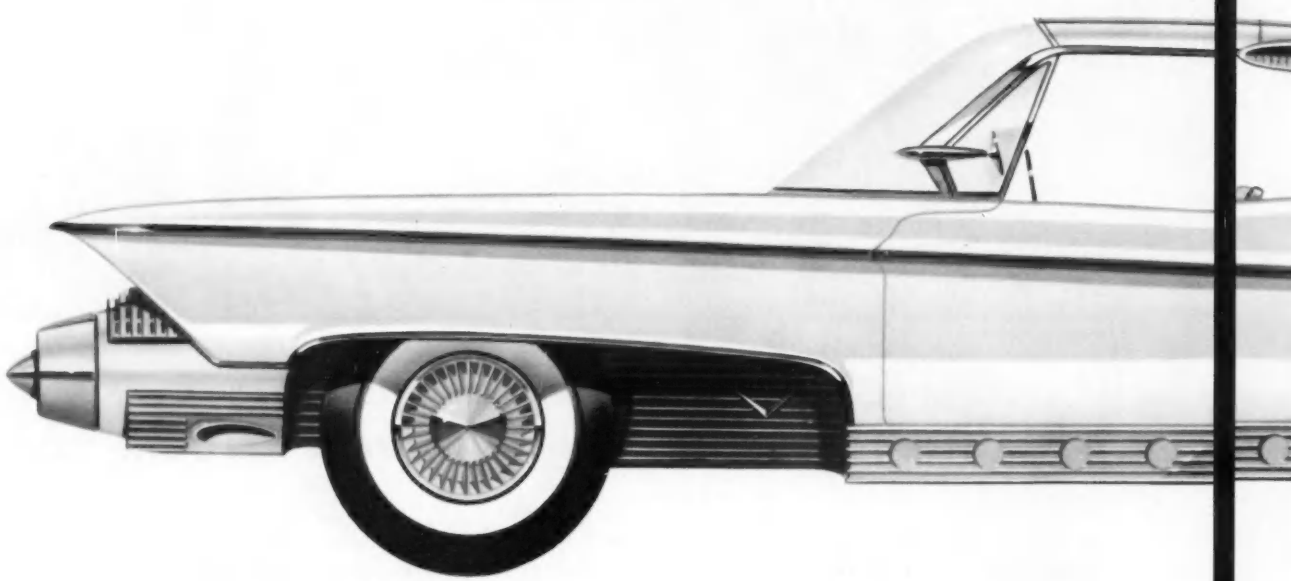
For a new and profitable experience in service and in steel controlled precisely to *your* needs . . . try us!

*Trade Mark National-Standard Company

NATIONAL STANDARD

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *tire wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *high and low carbon specialty wires*
WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

Exterior: *The Piedmont side view presents bold, straight-through styling in aluminum! Bright, full-length rub strip is integral with the stamped aluminum body panels and one-piece cast aluminum door. Anodized finish assures permanent beauty without painting. Ribbed lower side trim is exposed portion of cast aluminum frame. Wheel wells are ridged aluminum stampings; colored vinyl fills hollows between ridges. Decorative finned casting behind front bumper is aluminum exhaust muffler. Bumpers are cast and extruded aluminum. Retractable hardtop of aluminum sheet, forgings and castings folds to half its length, disappears into rear deck. Roll-away deck cover of aluminum extrusions and neoprene joining strips leaves opening unobstructed.*

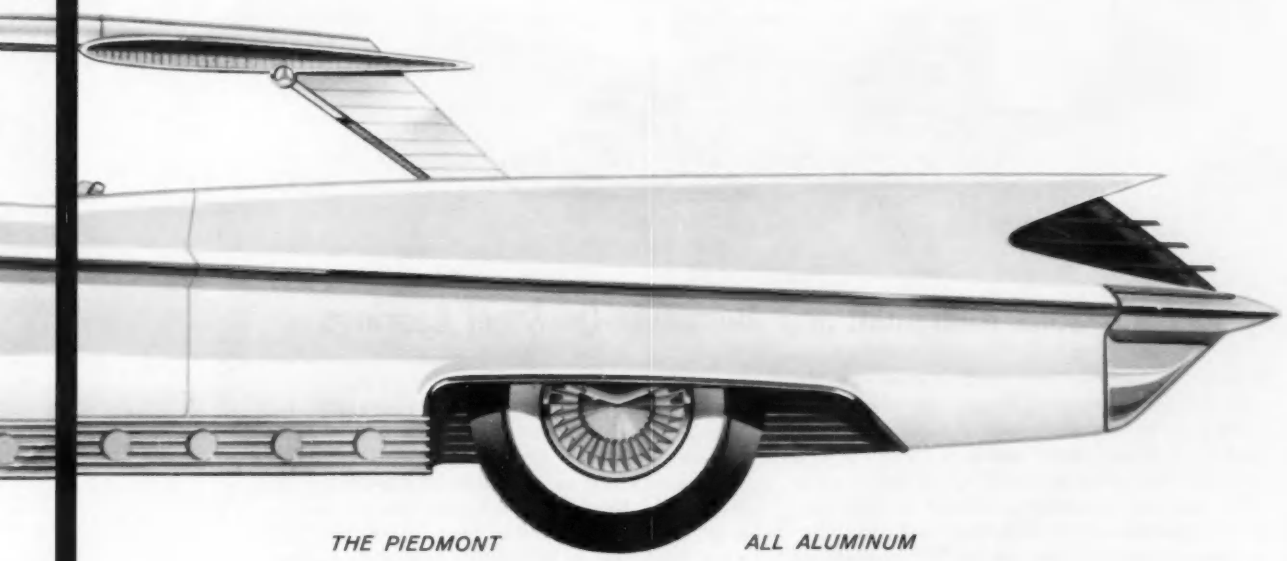


A KAISER ALUMINUM DESIGN

This Kaiser Aluminum design represents a concept of a car for the immediate future. Its purpose is to suggest aluminum's versatility . . . aluminum's infinite range of automotive design possibilities. The applications shown are logical, within the realm of present possibility.

Kaiser Aluminum will be pleased to work with you as your "idea partner" for further development of ideas suggested by this design.

Interior: *The Piedmont's interior presents an inspiration for experiment from firewall to seat back! Firewall, toeboard and panel parts are integrated into a single aluminum casting. This casting also includes heater-ventilator grilles and all necessary bosses and studs (for easy assembly). Speedometer numerals are cast into instrument cluster housing. Floorboards feature cast-in texture and pattern to eliminate need for carpeting, and all corners can be full-rounded to simplify sweeping and cleaning. Inner door panel shows another example of cast-in texture and trim with permanent anodized color. Seat frame of forged aluminum permits very light construction with sculptured styling. For the pivoted backrest, the seat back may be stamped, cast or extruded of aluminum, with unlimited variations of formed-in texture available for decorative trim.*

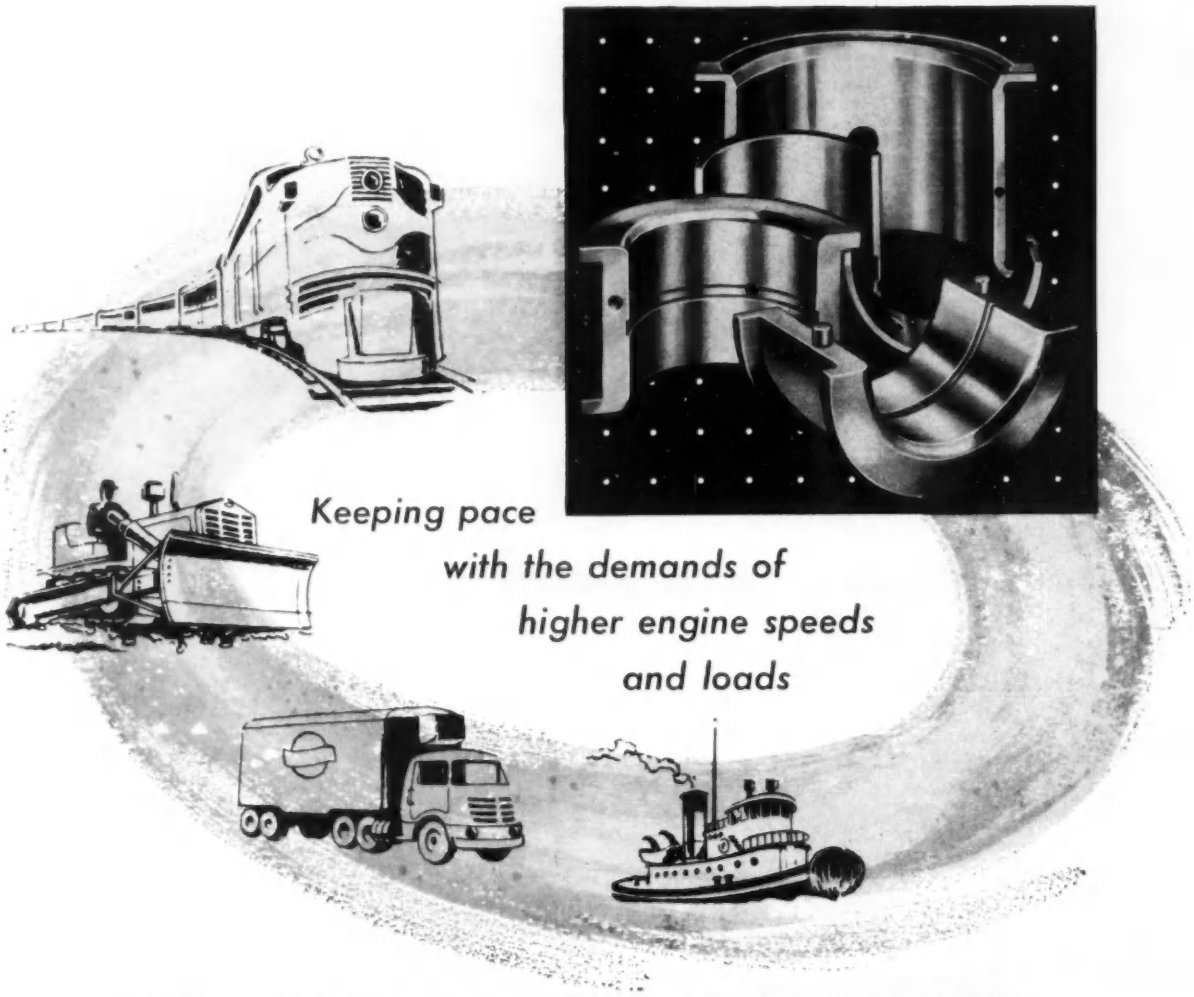


THE PIEDMONT *ALL ALUMINUM*

FOR IMAGINATION IN ALUMINUM

Call our Automotive Industry Division, TRinity 3-8000, Kaiser Aluminum & Chemical Sales, Inc., 2214 Fisher Building, Detroit 2, Michigan.

KAISER Aluminum



Johnson Solid Aluminum and Aluminum-On-Steel Bearings

For better performance, and to meet the demands of engine manufacturers, Johnson Bronze pioneered the development of solid aluminum and aluminum-on-steel bearings.

Solid aluminum bearings carry loads up to 4000 psi, and aluminum-on-steel to 6000 psi. These bearings have excellent embeddability properties, are ductile enough to conform to slight misalignments, and have high resistance to acid formation and attack by additive oils.

Johnson aluminum bearings are available in a wide range of plain or flanged, full or half bearings, with or without precision overlay. Take advantage of our years of experience in aluminum bearing design and production—your Johnson representative will be glad to work with you in improving the performance of your engines.

Johnson Bronze

675 South Mill Street • New Castle, Pa.

JOHNSON Bearings

POWDER METALLURGY—BRONZE OR IRON | ALUMINUM ON STEEL SOLID ALUMINUM | BRONZE ON STEEL | STEEL AND BABBITT | GRAPHITED BRONZE | BRONZE—CAST OR ROLLED

USING

DU PONT ELASTOMERS

neoprene · Hypalon®

in design

Bearing gives smoother performance, longer life because of neoprene housing and shaft seal

Convertible tops coated with HYPALON resist sunlight, weathering, discoloration, cracking

Among the many reasons for coating convertible tops with HYPALON is the long wear it provides. This new Du Pont synthetic rubber stays flexible at low temperatures; will not crack after prolonged exposure to all kinds of weather. HYPALON is exceptionally resistant to sunlight. And it can be compounded in an unlimited range of light-stable colors. Convertible tops coated with HYPALON also tailor and trim better in installation.

HYPALON doesn't develop a sticky surface to trap dirt and dust. Fabric coated with HYPALON resists soiling and when it finally does need cleaning, it washes clean with soap and water.

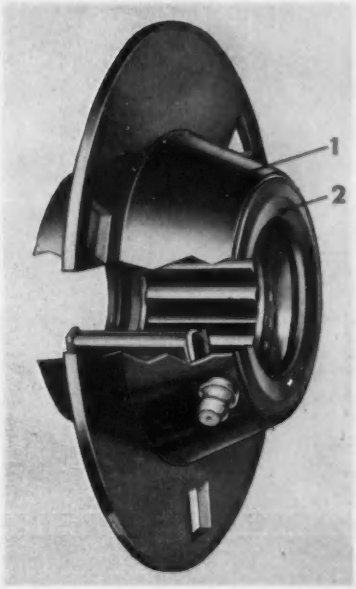
HYPALON is used in many other automotive items such as spark-plug boots, door stripping, whitewall tires. Its high resistance to ozone, heat, chemicals offer many more design opportunities. Mail coupon for full information.

Flexible neoprene housing on roller bearing adapts to instant changes in shaft alignment

This new cartridge type roller bearing, introduced by the Rollway Bearing Company of Syracuse, N. Y., is designed for use on farm and industrial materials handling equipment. It is made in shaft sizes from 1/2 to 1 7/16 inches. The bearing's flexible neoprene housing adjusts to shaft alignment changes caused by vehicle movement, or shifts in load distribution on the pulleys attached to the shaft. It permits misalignment between shaft and bolting flange of at least one degree. This adds considerably to bearing life and cuts fatigue on walls or panels to which the flange is mounted.

Rollway specified neoprene for the housing and shaft seal because it *keeps* its flexibility despite hard wear and extremes of temperature and humidity. Neoprene was also chosen for its outstanding resistance to oil and grease, and the abrasion of dirt and grit present in many installations. Regular bearing lubrication has no effect on the neoprene seal.

This is but one example of good design made possible with neoprene's *balanced combination* of useful properties. Du Pont's synthetic rubber is used throughout the automotive industry in applications where resistance to oil and grease, acids, abrasion, sunlight and weather are important. For more information, just clip and mail the coupon below.



1. Neoprene housing permits shaft alignment changes
2. Neoprene seal retains lubricant, seals out dirt

DU PONT

REG. U. S. PAT. OFF.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc).*

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☐ Please add my name to the mailing list for your free publication, the ELASTOMERS NOTEBOOK.

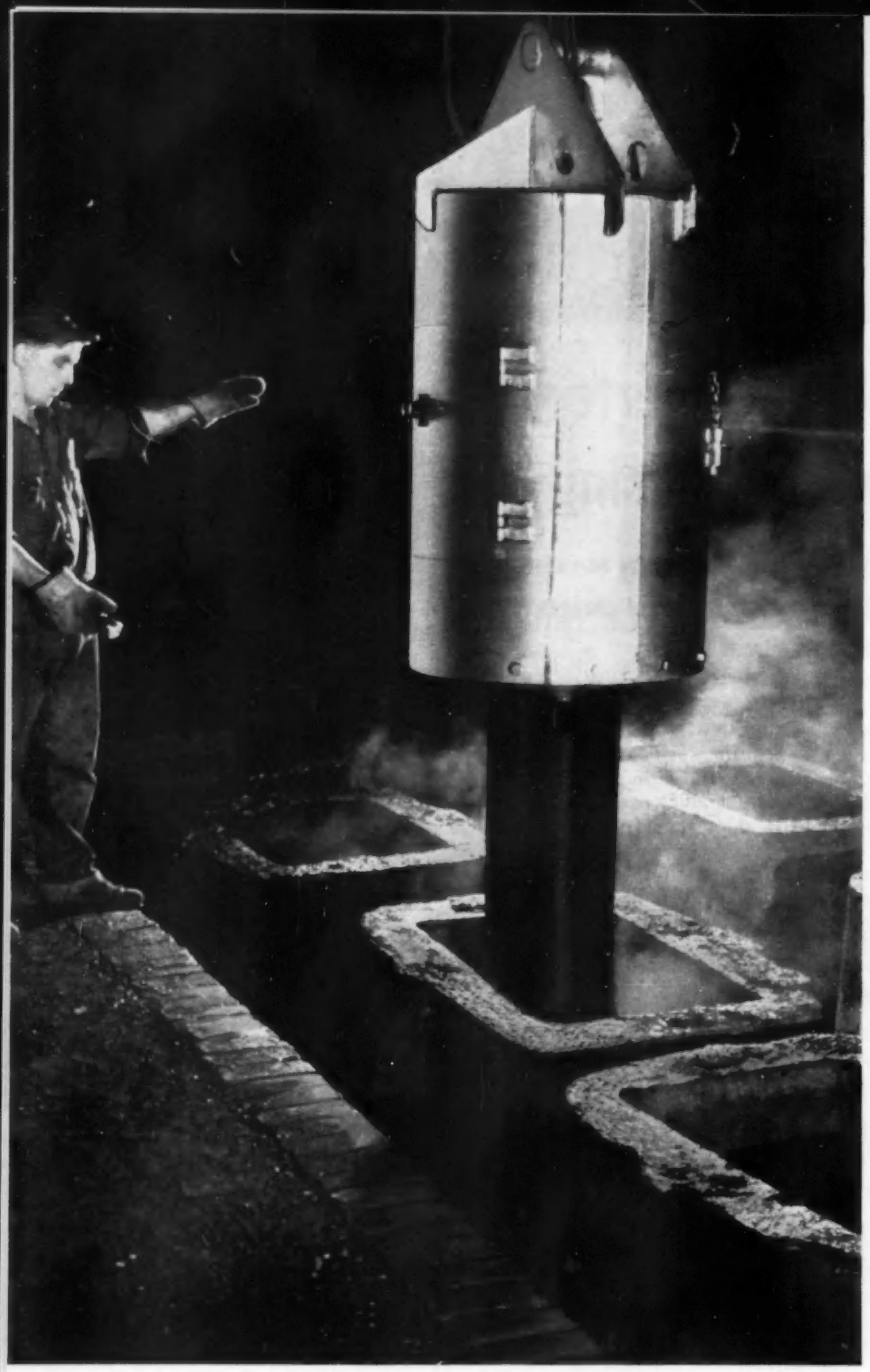
Name _____ Position _____

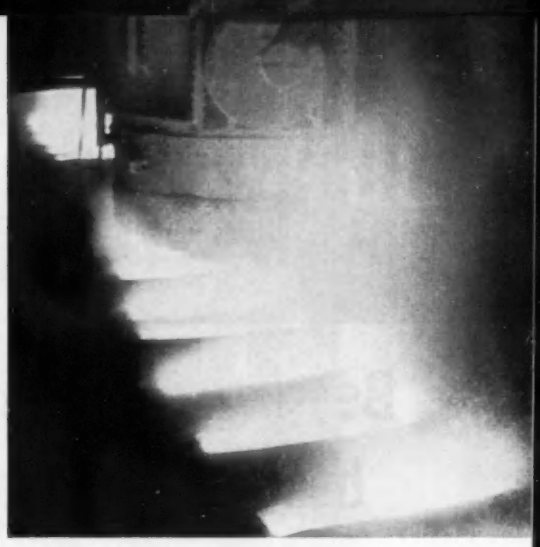
E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. SAE-10
Wilmington 98, Delaware

Firm _____

Address _____

City _____ State _____





A giant 250-ton teeming ladle (shown above) fills a train of ingot molds at Great Lakes Steel.

Cooling the empty molds with a water spray (below) gives more uniform cooling rate, assures return of molds at proper temperature.

How Great Lakes Steel *coats ingot molds* for quality

At Great Lakes Steel, ingot molds get a high-temperature resinous coating by means of America's fastest spinner applicator (see picture above). Rotating at 1,700—2,000 rpm, the applicator applies a more even coating to the molds. In just ten minutes, 28 molds are lined with a highly protective shield for the ingot surface. Repeated before each use, this added step in production helps eliminate defects by repelling splashes of molten metal from the mold walls.

This is only one of the hundreds of methods and operations used by Great Lakes right from the start of steel making to maintain the high and uniform quality of its products. This uniform quality can mean real savings to you.

It's easy to get the full story of Great Lakes quality—and dependability, too. Simply pick up your phone and call our nearest representative.

GREAT LAKES STEEL CORPORATION

Detroit 29, Michigan • Division of

NATIONAL STEEL CORPORATION

District Sales Offices: Boston, Chicago, Cincinnati, Cleveland, Grand Rapids, Houston, Indianapolis, Lansing, Los Angeles, New York City, Philadelphia, Pittsburgh, Rochester, St. Louis, San Francisco, Toledo, Toronto.

THIS SKF

Red Seal IS YOUR BEARING INSURANCE

When ball bearings are invaded by external dirt, life is cut short. If dirt can get in, so can other contaminants... and lubricant can leak out.

But when the SKF Red Seal is used... dirt and moisture are repelled and lubricant is positively retained until replaced.

DuPont Fairprene, the material of the Red Seal, remains unaffected by lubricants, heat, ageing and moisture. Reinforced by a securely staked steel retaining ring, it provides maximum sealing, lightest contact, lowest friction—for the life of the bearing.

Designed for use by manufacturers of motors, portable tools, household appliances and other equipment requiring efficiently sealed bearings. Available in all standard S.A.E. widths, fully interchangeable with non-sealed bearings. 7783

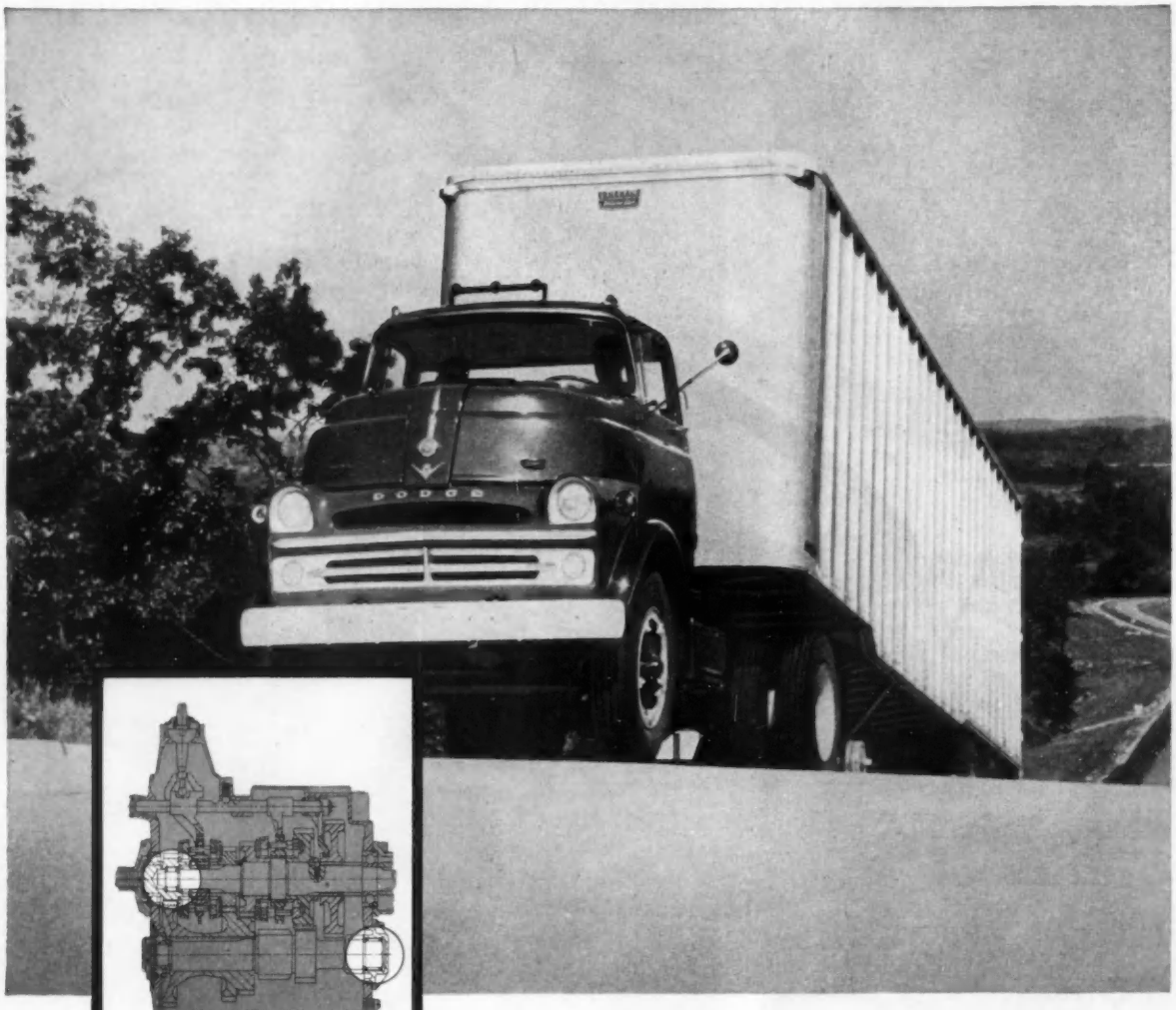
EVERY TYPE—EVERY USE

SKF®

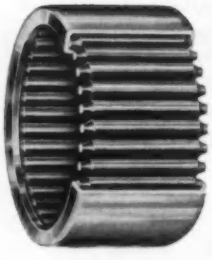
Ball Bearings
Cylindrical Roller Bearings
Spherical Roller Bearings
Tapered Roller Bearings ("Tyson")

* Reg. U.S. Pat. Off. Tyson Bearing Corporation

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.



This Dodge "Power Giant" truck is equipped with the New Process Gear Corporation Model 540 5-Speed Truck Transmission, containing a Torrington Needle Bearing in the rear countershaft position and a Torrington Needle Roller assembly between the mainshaft pilot and the drive gear.



Over the long haul...

New Process Gear Corporation truck transmissions are a favorite among America's leading truck manufacturers because of their high ratio of capacity to size. Contributing to their reliable performance and smooth operation are compact, high-capacity Torrington Needle Bearings.

These efficient, anti-friction bearings were chosen for use in these heavy-duty truck transmissions because they provide unequaled radial load capacity with the smallest possible cross section. Smooth, efficient functioning and easy maintenance are assured since the bearings start and operate with a minimum of friction and retain lubricant effectively.

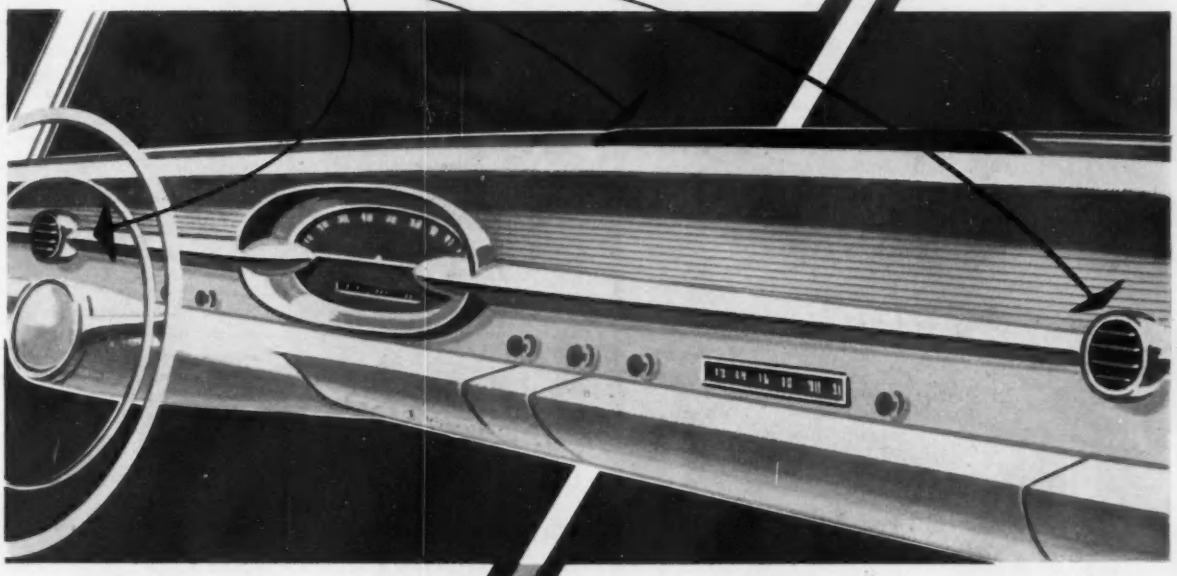
These qualities, which have won Torrington Needle Bearings leadership in the field, have also led to their use in all types of automotive equipment: steering knuckles, brakes, clutches, hydraulic pumps and many others. If your product would benefit from compact, anti-friction Needle Bearings with high capacity and long service life, talk to your Torrington representative who will be glad to give you engineering assistance. Or, if you'd prefer, write: **The Torrington Company, Torrington, Conn. – and South Bend 21, Ind.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE ROLLERS • BALL • THRUST

Through these outlets pours the coolest air on the road!



Again in '58

HARRISON AIR CONDITIONS THE FAMOUS FIVE!

OLDSMOBILE

CHEVROLET

Pontiac

Cadillac

BUICK

Cool . . . cool . . . cool—that's a Harrison Air Conditioned General Motors car. And again in 1958, Harrison gets the call to cool GM's famous five! Every Harrison Air Conditioner is tailor-made, designed expressly to fit each make of car. Passengers cruise in cool comfort, free from heat and high humidity . . . dust and road noise. It's the biggest *plus* in driving comfort in many years! And it's not surprising that Harrison is today's leading manufacturer of car air conditioning. Leading automotive manufacturers have looked to Harrison for top-quality heat-control products for over 47 years. That's why you'll find Harrison Air Conditioners specified on the 1958 Cadillac, Buick, Oldsmobile, Pontiac and Chevrolet.

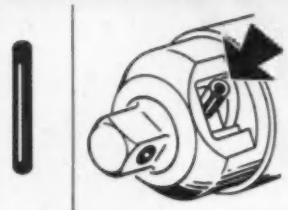
TEMPERATURES MADE TO ORDER

HARRISON

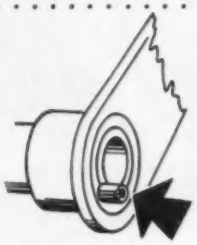
GM GENERAL MOTORS

HARRISON RADIATOR DIVISION • GENERAL MOTORS CORPORATION • LOCKPORT, N. Y.

Rollpin® replaces 12 different fasteners

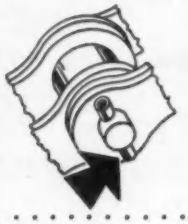


REPLACING A GROOVED PIN . . . in this application, Rollpin serves as a step pin in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.



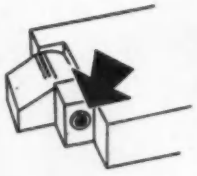
REPLACING A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than previous assemblies.

REPLACING A RIVET SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.

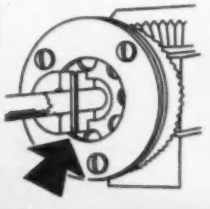


REPLACING A COTTER PIN . . . Rollpin assembly time is shorter, service life ten times longer. Vibration-proof flush fit. Easily removable.

REPLACING A SET SCREW . . . to fasten automobile brake handle a short length Rollpin is self-retained in the hand grip but can easily be driven into over-drilled hole in shaft for simple handle removal.

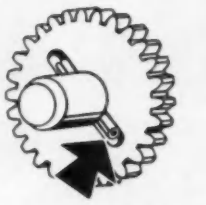


REPLACING A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application shown is the plate of a home workshop tool.

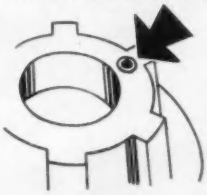


REPLACING TAPER PINS . . . in the assembly of precision differentials eliminated cost of taper pin reamers and the entire reaming operation. Rollpin costs less than a taper pin and installation is cheaper. They remove easily.

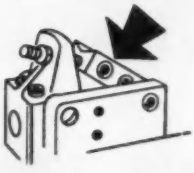
REPLACING A HEADED PIN . . . in this hinge pin application, Rollpin is simply and inexpensively driven in place, greatly reducing assembly costs. Constant spring tension holds Rollpin firmly in place . . . eliminates loosening of hinge due to wear.



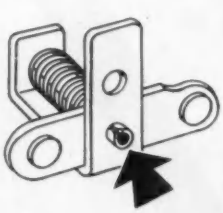
REPLACING A HUB ON A GEAR . . . Rollpin, self-retained in shaft, is simply snapped into molded slot to position sintered gear. This application, by an office equipment manufacturer, effects major savings in assembly. Rollpin's high shear strength is particularly valuable here.



REPLACING A DOWEL PIN . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.



REPLACING A BOLT AND NUT . . . Rollpins act as fasteners and pivots for the linkages in this electric welder. Rollpins may be used with a free fit in outer or inner members depending upon product design requirements.



REPLACING A RIVET . . . Rollpin serves as guide shaft for spring-loaded electrical interlock contacts. This electrical equipment manufacturer reports that rivet failure previously occurred at the clinched end under normal operating impact and vibration.

WHERE CAN YOU USE THIS SIMPLE FASTENER?

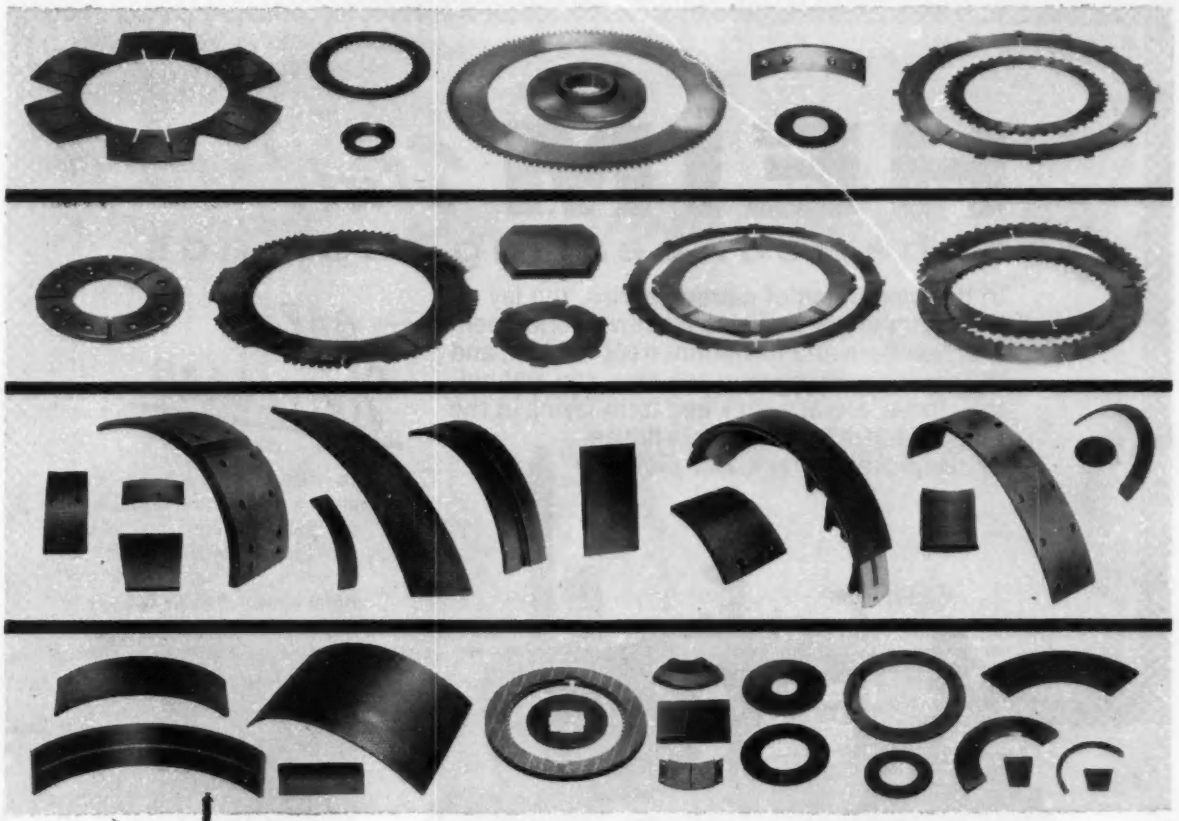
Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

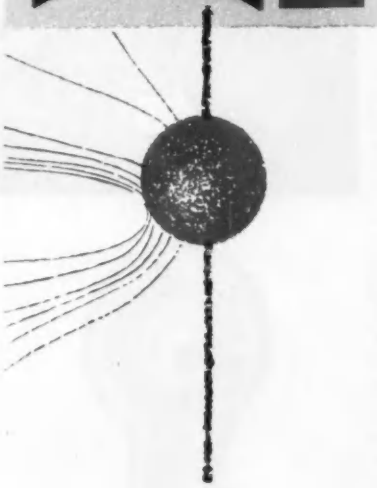
Drives easily into standard holes, compressing as driven. Spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole. Made in carbon steel, stainless steel and beryllium copper. Write for samples and information, ELASTIC STOP NUT CORPORATION OF AMERICA, 2330 Vauxhall Road, Dept. B47-1075 Union, New Jersey.

ROLLPIN TRADEMARK

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 VAUXHALL ROAD, UNION, NEW JERSEY





ON THE SHELF

to give you greater design freedom

IF your engineering creativeness is blocked from promising solutions by the limitations of friction materials you know about . . .

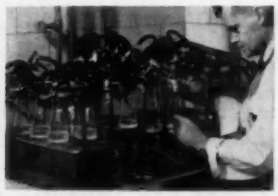
IF you face a target date that precludes "from scratch" development and testing of either organic or sintered metal materials basic to new designs . . .

You may find your answer already "on the shelf" at American Brakeblok. Continuous research sets new friction material standards. A wide range of new materials—with exceptional static and kinetic friction coefficients, fade and recovery values, temperature resistance and wear resistance—is backed by detailed test data, and available for immediate use. Let's talk over your problem.

FRICTION PROBLEMS SOLVED IN ADVANCE

American Brakeblok
REG. U. S. PAT. OFF.
FRICTION MATERIALS

Basic chemical research develops new formulations



Quality control insures performance standards

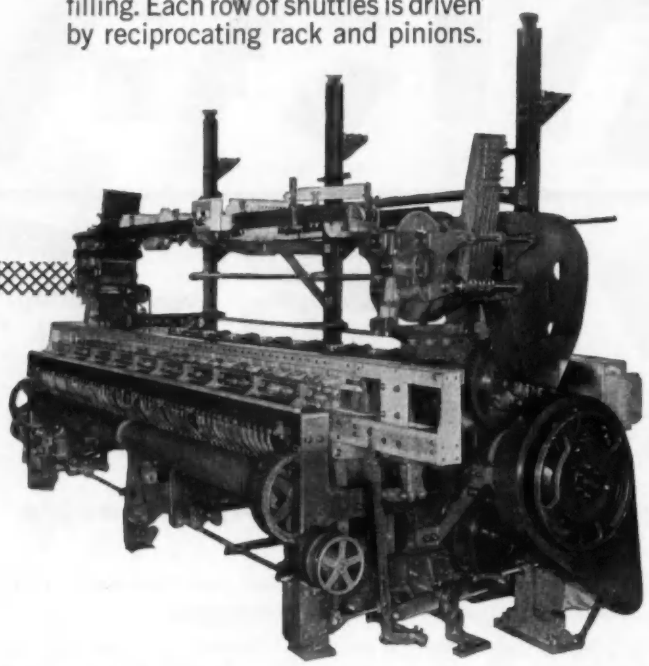
Brake Shoe COMPANY

AMERICAN BRAKEBLOK DIVISION
DETROIT 9, MICHIGAN

HEIM *Unibal*

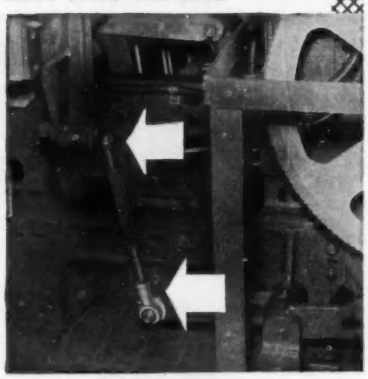
spherical bearing rod ends

In the production of narrow fabrics, the lay on the Crompton & Knowles Narrow Fabric Loom is driven back and forth from front to back, and the shuttles, arranged in two rows, top and bottom, move laterally back and forth laying in the filling. Each row of shuttles is driven by reciprocating rack and pinions.



are Necessary

To take care of inherent misalignments due to the backward and forward motion of the lay, and the lateral motion of the rack rods, **it is necessary to use HEIM Unibal Rod Ends.**

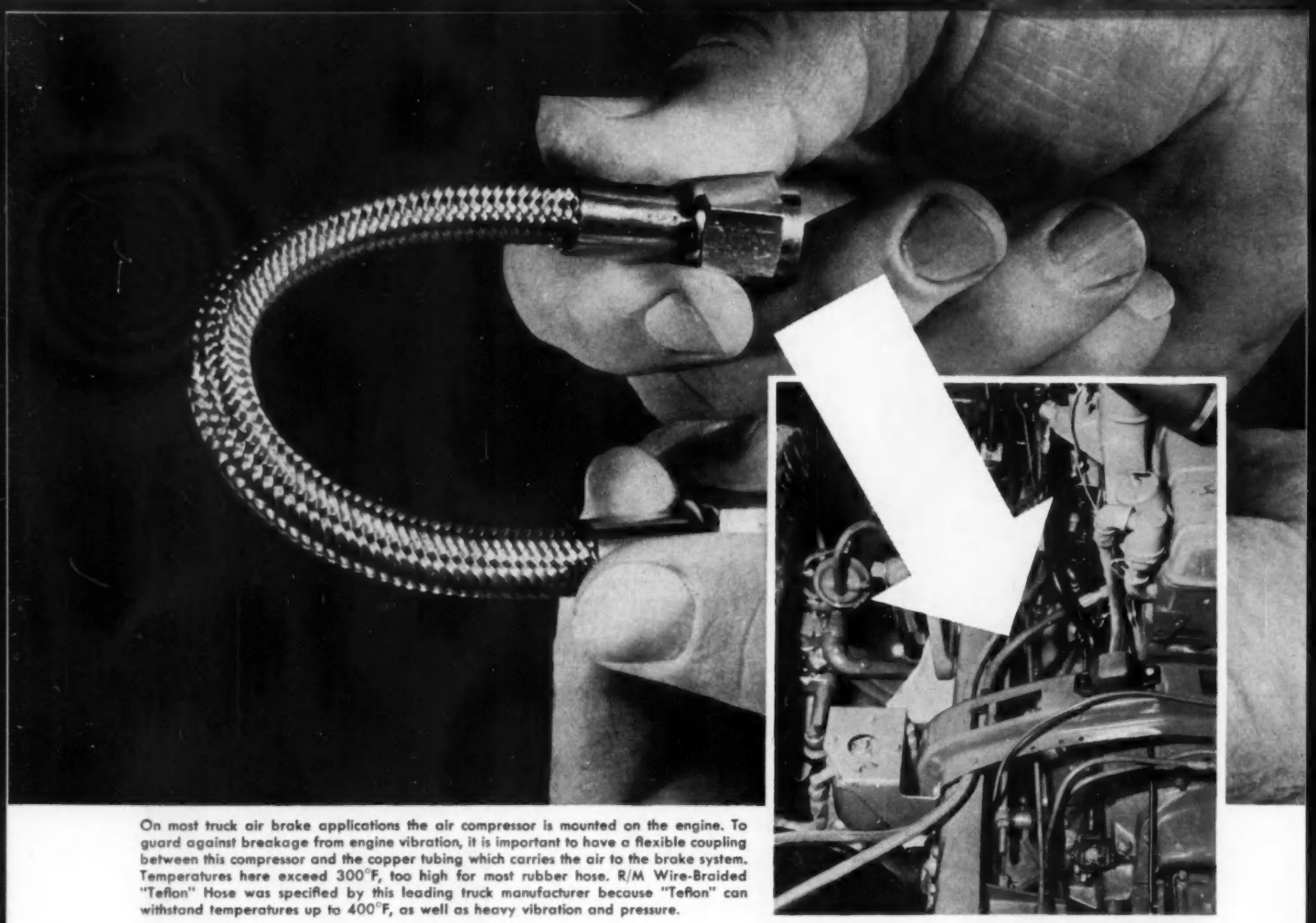


Correcting operating misalignment is just one indispensable feature of Heim Unibal. They have a greater surface supporting area, and are able to carry heavier axial and thrust loads. They reduce friction and lost motion, and eliminate brinelling. They are economical to buy, easy to install, and have a wide variety of uses.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

Be sure you have the Heim Catalog showing sizes and load ratings

Send for a free sample so you can see for yourself this unusual, self-aligning Unibal principle.



On most truck air brake applications the air compressor is mounted on the engine. To guard against breakage from engine vibration, it is important to have a flexible coupling between this compressor and the copper tubing which carries the air to the brake system. Temperatures here exceed 300°F, too high for most rubber hose. R/M Wire-Braided "Teflon" Hose was specified by this leading truck manufacturer because "Teflon" can withstand temperatures up to 400°F, as well as heavy vibration and pressure.

To withstand heat, vibration, pressure and corrosive chemicals . . . R/M "TEFLON"* HOSE

Where heat, pressure, vibration or corrosive fluids are factors, R/M Thin-Wall Flexible "Teflon" Hose may well be the most economical, as well as the most effective, solution to your problem.

R/M "Teflon" has unique chemical, electrical and physical properties. It can be kept in continuous service at temperatures from — 100° to 400°F. It is impervious to chemical attack. It is highly flexible. It does not expand, contract or fatigue. And it has an extremely low coefficient of friction—reducing pressure drop in fluid systems to the minimum.

The proper manufacture of "Teflon" parts requires knowledge and skills that only experience can provide. Raybestos-Manhattan pioneered in the development of "Teflon" products for the automotive and aircraft industries. And R/M research and testing laboratories have been ceaselessly at work to widen their use.

R/M Thin-Wall Flexible "Teflon" Hose is made in a wide range of inside diameters and wall thicknesses—available either with stainless steel wire-braided jacket or rubber covered. Other R/M "Teflon" products include rods, sheets, tubes and tape; centerless ground rods held to very close tolerances; stress-relieved molded rods and tubes; and custom-machined parts. Raylon—R/M trade name for mechanical grade "Teflon"—has many characteristics of virgin "Teflon."

If you would like further information on R/M "Teflon" and what it could do for you, remember that R/M is as near as your telephone.

*Du Pont trademark

R/M
FIRST IN FRICTION

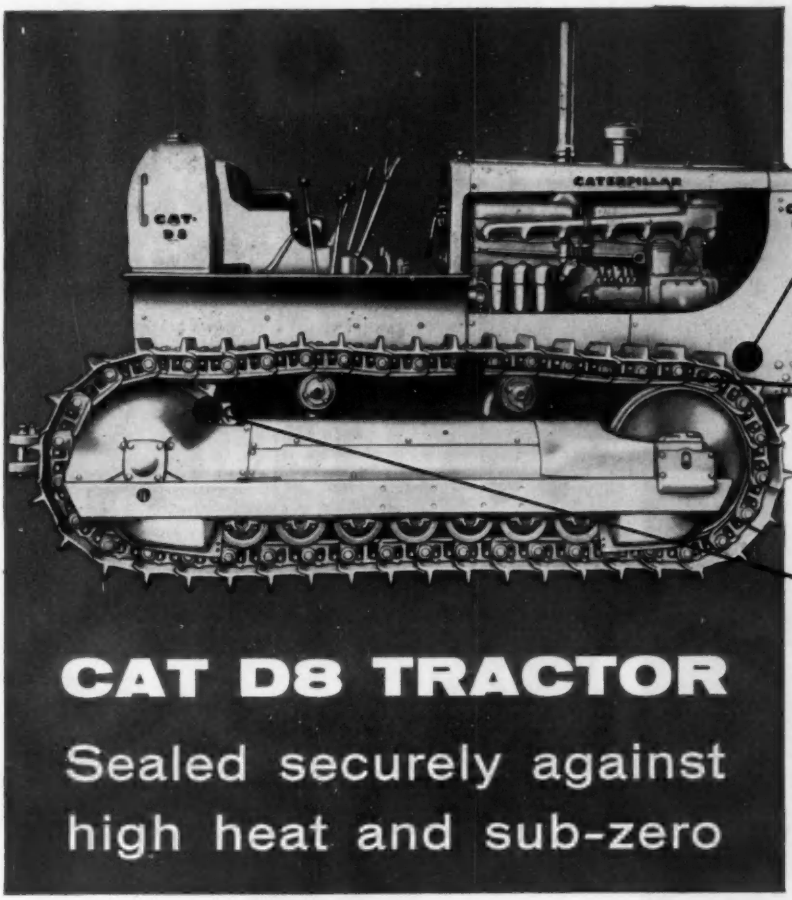
THE TRADEMARK THAT SPELLS PROGRESS
IN FRICTION MATERIAL DEVELOPMENT

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION: Bridgeport, Conn. • Chicago 31 • Cleveland 16 • Detroit 2 • Los Angeles 58

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; Passaic, N.J.; No. Charleston, S.C.; Crawfordsville, Ind.; Neenah, Wis.; Raybestos-Manhattan (Canada) Limited, Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Brake Linings • Brake Blocks • Clutch Facings • Sintered Metal Products • Industrial Adhesives Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics • Rubber Covered Equipment Abrasive and Diamond Wheels • Laundry Pads and Covers • Bowling Balls



Front Crankshaft Seal—Type K-6 dual lip design with high heat- and oil-resisting Victoprene sealing element. Metal O. D. assures perfect press fit.

Rear Crankshaft Split Seal—Two-section Victoprene seal eliminates need of dropping shaft when removing and replacing. Semicircular molded construction integral with frame. Victoprene coating on O.D.

Beveled Gear Shaft and Pinion Seals—Type K-6 dual sealing lip design provides maximum retention of lubricant and exclusion of foreign matter. Spring maintains uniform sealing pressure. Chemically bonded to metal-encased construction.

with Victoprene silicone and polyacrylic compounds

Oil seals, shown above, on the Caterpillar D8 tractor make a clean break with former standards for extreme operating conditions and oil-resistance characteristics. They're specified for the toughest working conditions facing construction and road building machinery.

As fast as your new sealing requirements develop, count on Victor for complete help in meeting each specification. The answer may be in the variety of Victor-developed synthetic compounds and designs with excellent resistance to low and high temperatures.

You can be sure of a modern approach to your problem. At Victor there's never a standstill in searching for better sealing compounds for old and new applications alike.

New Engineering Catalog No. 305 Sent on Request

You'll find much useful data in this 60-page manual on modern oil seal specification procedure. Get a copy from your Victor Field Engineer or write directly to Victor.

Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill.
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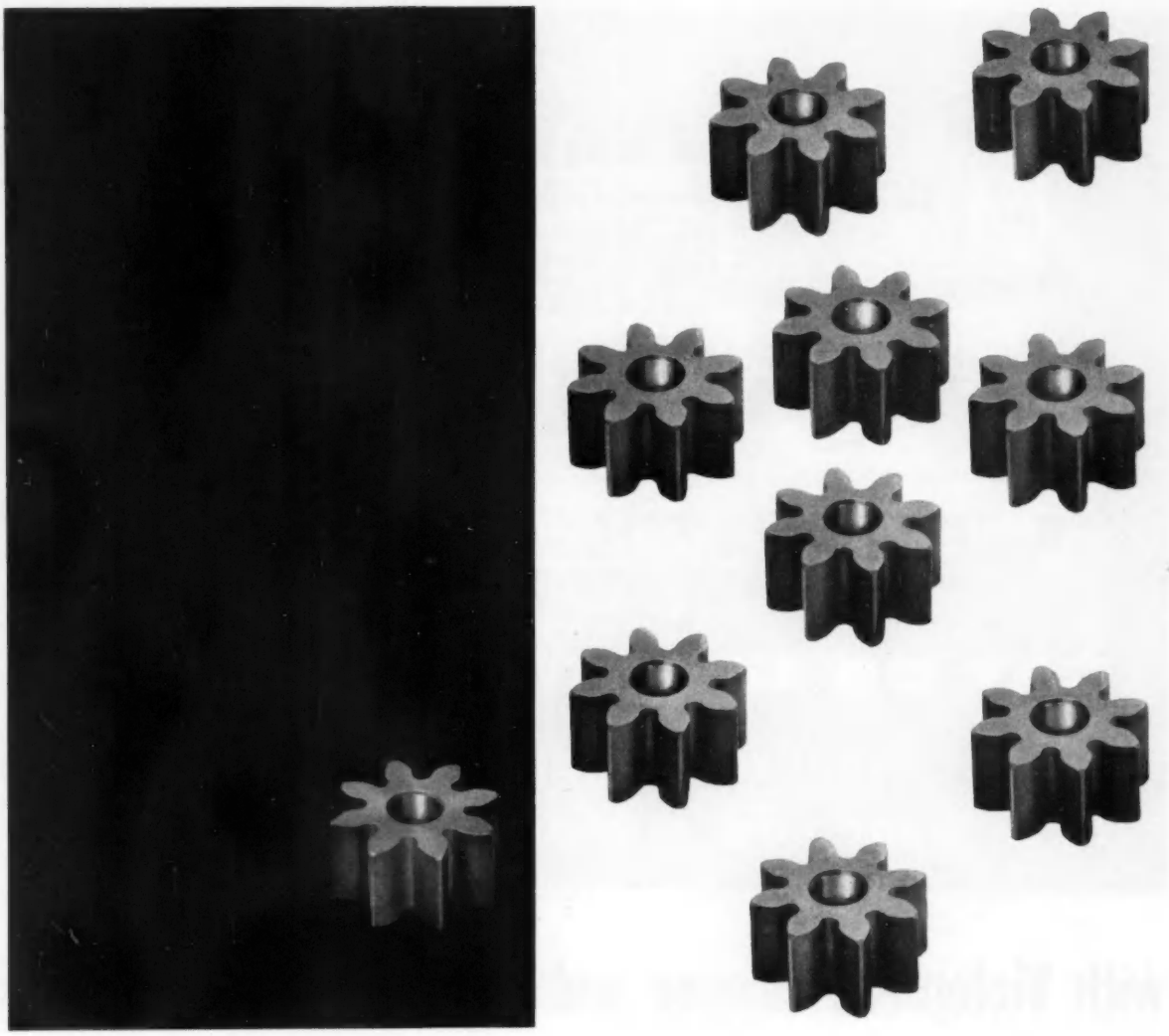
VICTOR

Sealing Products *Exclusively*

OIL SEALS • GASKETS • PACKINGS • MECHANICAL SEALS



What about *wear* with metal powder parts?

Resistance to wear is an outstanding characteristic of the oil pump gears illustrated here. Moraine Products makes them of metal powder and holds them to exceptionally close tolerances. Gear teeth have unexcelled finish and uniformity. The result is dependable, quiet performance under any operating condition. For this application, as for so many others, long-wearing metal powder parts by Moraine Products have proved themselves to be the modern, economical answer.

Moraine Products also produces: Moraine Power Brakes • Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts • Moraine friction materials • Moraine-400 and M-100 automotive engine bearings • self-lubricating bearings and porous metal filters • rolled bronze and bi-metal bushings.

GM
FORWARD FROM FIFTY

Moraine Products
Division of General Motors, Dayton, Ohio

BOHN EXPANDS EXTRUDED TRIM FACILITIES TO ALL INDUSTRY!

One of America's oldest extruders, with years of anodizing and fabricating experience, Bohn now offers:

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- Complete quality control—a prime requisite for the best possible finished products!
- Extruded trim in a wide range of sizes and shapes!
- Design assistance by experienced Bohn Engineers and Metallurgists!

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HIGHER EDUCATION
KEEP IT BRIGHT

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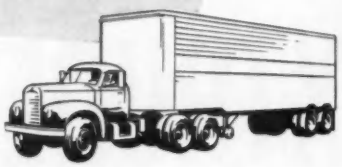
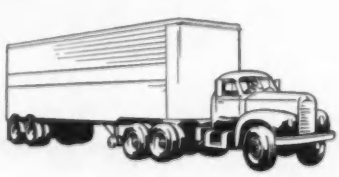
Only MIDLAND Goes Beyond ICC Braking Requirements With All These Positive-Plus Features!

Have you converted your tractor-trailers to comply with the new ICC emergency braking regulations? If not, be sure to specify Midland equipment, for only Midland gives you all these EXTRA SAFETY AND ECONOMY FEATURES — *in addition, of course, to the basic ICC requirements.*



ICC Requires that . . .	MIDLAND Gives You These *PLUS* Features . . .	
Tractors must be equipped with two means of activating the emergency feature of the trailer brakes.	• **MIDLAND DASH CONTROL VALVE** applies and releases trailer brakes as fast as service brake. • **MIDLAND DASH CONTROL VALVE** is pull-type to eliminate accidental application.	• **MIDLAND DASH CONTROL VALVE** provides visual indication whether or not trailer system is charged. • **MIDLAND DASH CONTROL VALVE** provides automatic application below low pressure warning point so that vehicle can clear traffic lanes.
Tractor brake system must be protected against air loss in the event of trailer breakaway or leakage in trailer system.	• **MIDLAND TRACTOR PROTECTION VALVE** can be installed on your present shut-off cock brackets. • **MIDLAND TRACTOR PROTECTION VALVE** has rugged mounting for protection on breakaway.	• **MIDLAND TRACTOR PROTECTION VALVE** works with all types of emergency relay valves.
All new trailers must have a "no-bleed-back" emergency relay valve to prevent back flow of air from reservoir through supply line.	• **MIDLAND EMERGENCY RELAY VALVE** is large capacity for fast application and release. • **MIDLAND EMERGENCY RELAY VALVE** eliminates danger of vehicle drive-away without sufficient air in system.	• **MIDLAND EMERGENCY RELAY VALVE** is easily serviceable without removal from vehicle. • **MIDLAND EMERGENCY RELAY VALVE** gradually applies the trailer brakes in the event of loss of air below 45 psi.



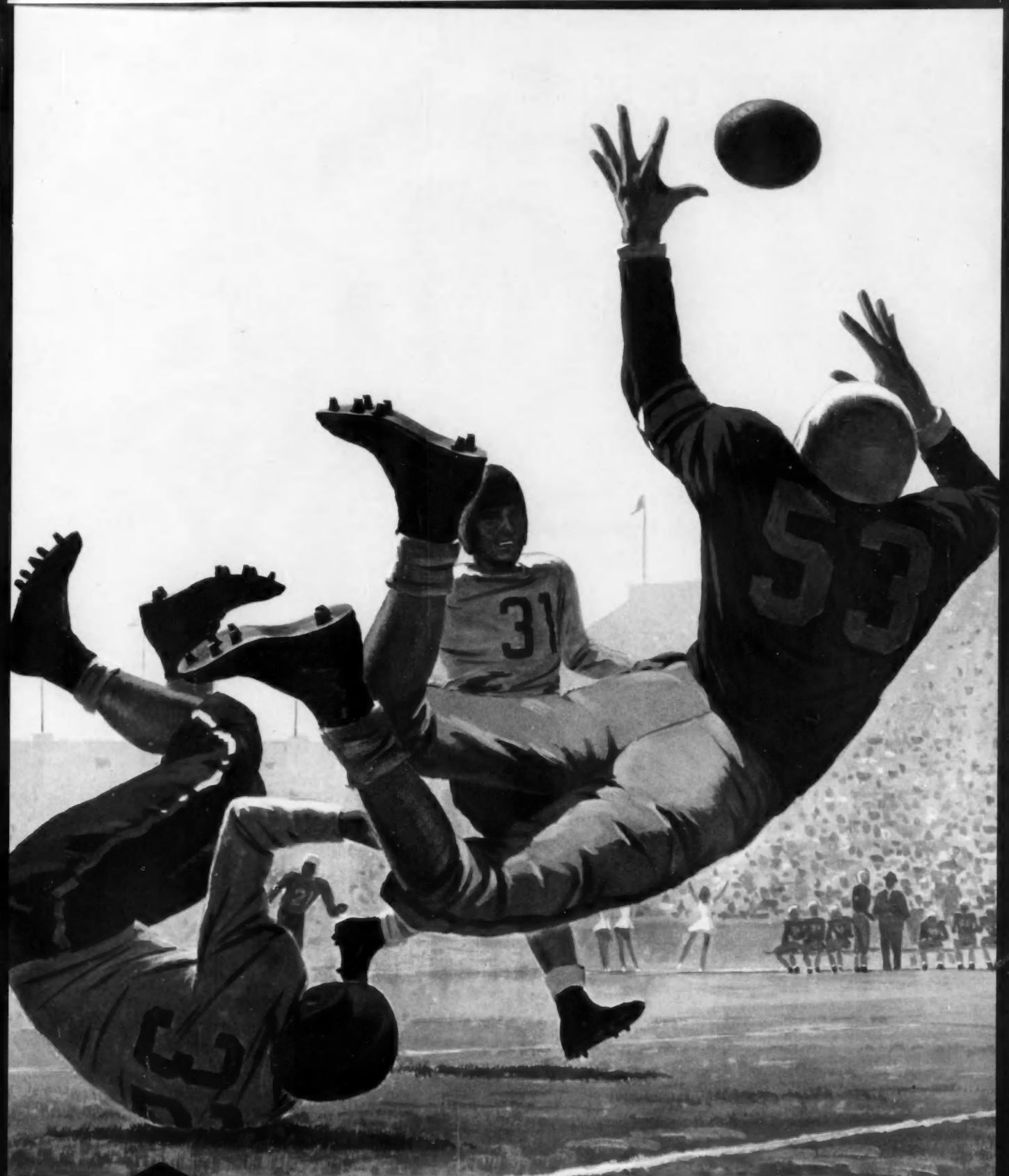
MIDLAND STEEL PRODUCTS CO

Ask your nearest Midland Distributor for complete information on equipping your tractor-trailers to comply with the latest ICC braking regulations. He'll welcome a chance to serve you.

THE MIDLAND STEEL PRODUCTS COMPANY

OWOSSO DIVISION • OWOSSO, MICHIGAN

***Export Department:* 38 Pearl Street, New York, N.Y.**



DANA

You have to stay on your feet .....

You have to stay on your feet . . .
If you want to carry the ball

For 53 years, the Spicer Universal Joint has stayed on its feet, continuously and uninterruptedly . . . each year carrying the ball to new goals of efficient design and dependable performance. There is nothing finer in the field . . . there is nothing quite so modern, so rugged, so universally used for every type of automotive power transmission.

DANA CORPORATION
Toledo 1, Ohio

DANA PRODUCTS Serve Many Fields:

AUTOMOTIVE: Transmissions, Universal Joints, Propeller Shafts, Axles, Powr-Lok Differentials, Torque Converters, Gear Boxes, Power Take-Offs, Power Take-Off Joints, Clutches, Frames, Forgings, Stampings.

INDUSTRIAL VEHICLES AND EQUIPMENT: Transmissions, Universal Joints, Propeller Shafts, Axles, Gear Boxes, Clutches, Forgings, Stampings.

AVIATION: Universal Joints, Propeller Shafts, Axles, Gears, Forgings, Stampings.

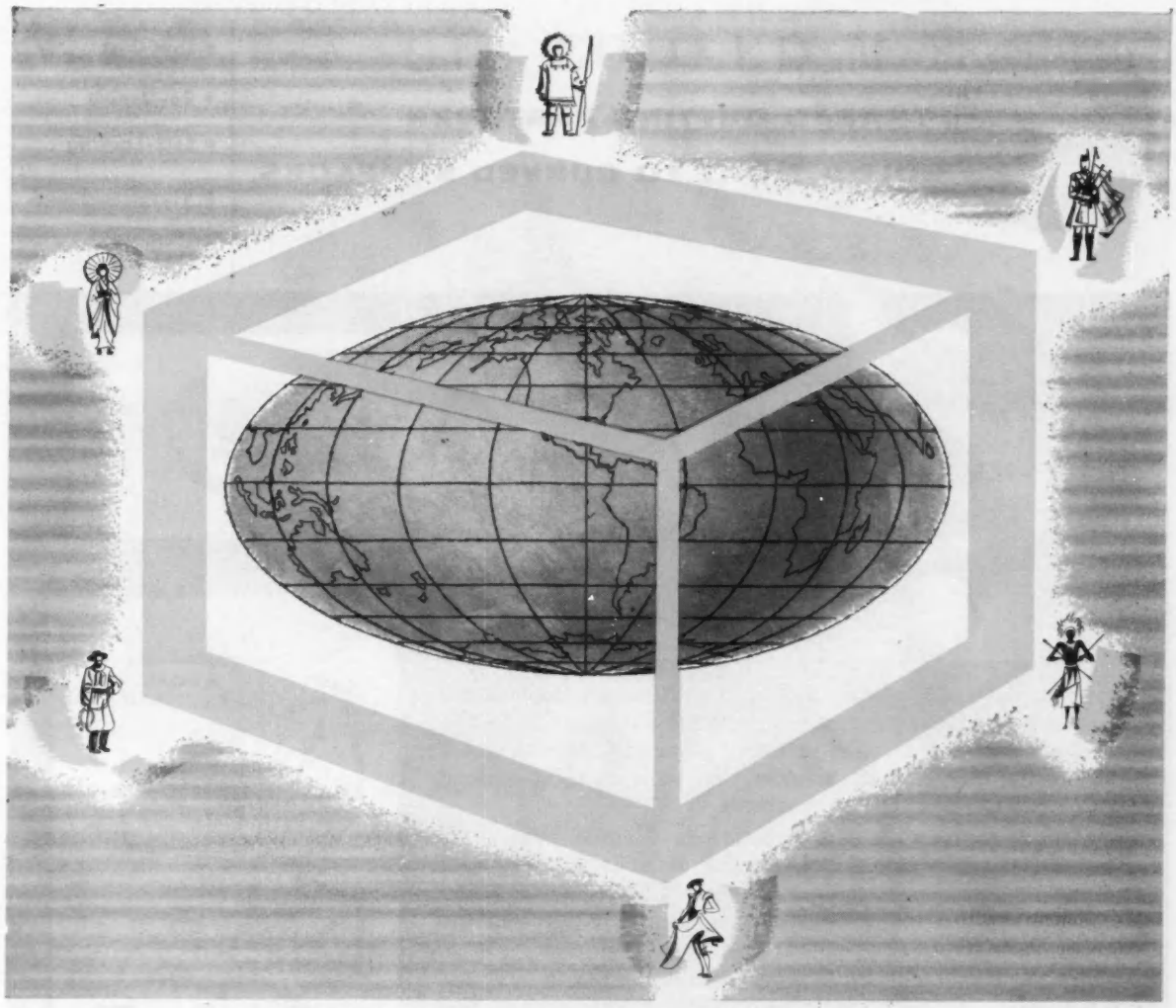
RAILROAD: Transmissions, Universal Joints, Propeller Shafts, Generator Drives, Rail Car Drives, Pressed Steel Parts, Traction Motor Drives, Forgings, Stampings.

AGRICULTURE: Universal Joints, Propeller Shafts, Axles, Power Take-Offs, Power Take-Off Joints, Clutches, Forgings, Stampings.

MARINE: Universal Joints, Propeller Shafts, Gear Boxes, Forgings, Stampings.

Many of these products manufactured in Canada by Hayes Steel Products Limited, Merrilton, Ontario

DANA
Spicer



In the far corners of the globe...

The performance and the brand are the same around the world

Shell Rimula Oil is a heavy-duty oil designed to solve the toughest lubricating problems in diesel engines.

Rimula® Oil reduces cylinder and bearing wear caused by acidic combustion products that are increased by low jacket temperatures. It remains stable under the widest temperature extremes encountered in modern operation. It keeps engine parts clean and operating efficiently over longer periods...effecting worth-while savings in labor and parts.

Rimula Oil, regarded in the U.S.A. by manufacturers and operators as an indispensable accessory to heavy-duty vehicular operation, is available to your customers abroad under the same brand. For full information, write: Shell Oil Company, 50 West 50th St., New York 20, N. Y., or 100 Bush St., San Francisco 6, Calif.

Other outstanding Shell Industrial Lubricants

Shell Tellus Oil—for closed hydraulic systems

Shell Alvania Grease—multi-purpose industrial lubricant

Shell Turbo Oils—for utility, industrial & marine turbines

Shell Dromus Oil—cutting oils for high-production metalworking

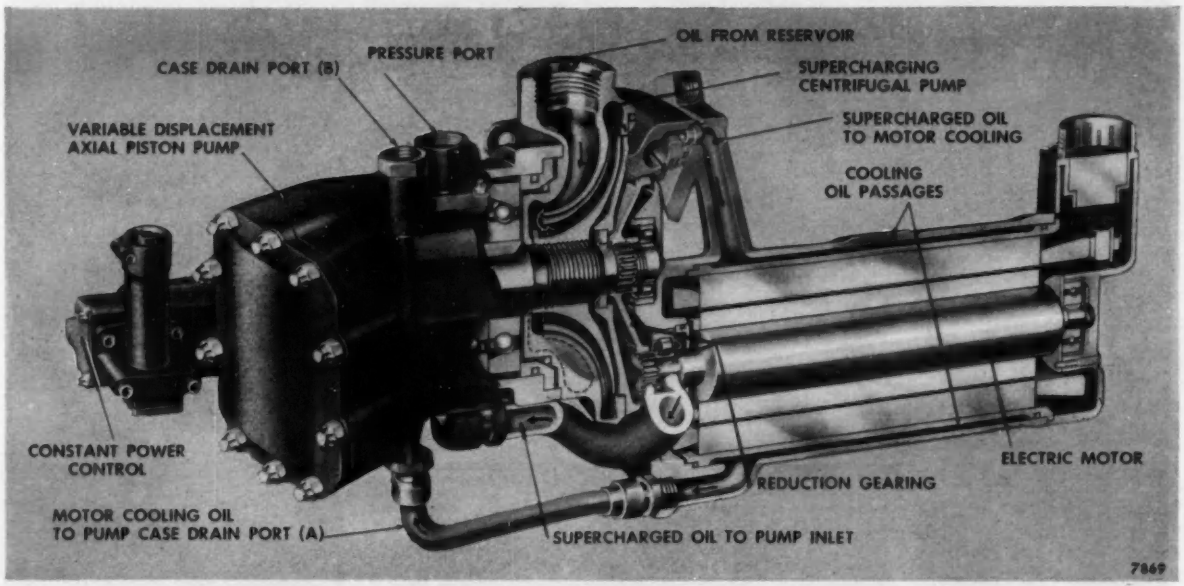
Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

SHELL RIMULA OIL

SHELL

New Vickers OIL COOLED Motorpump

For Continuous Duty Applications



Installed weight approximately 25% less; also offers significant size reduction

The 12 horsepower oil cooled motorpump shown above weighs 31¼ lb and is 20" long overall . . . motor diameter is less than 4". This represents a substantial saving in weight and size over the conventional air cooled motorpump. Also, there is a further saving with the elimination of duct work in the airframe normally required for air cooling the electric motor. The motorpump illustrated *is now in quantity production* for turbine powered transports.

The time-proven Vickers variable displacement piston type pump, which is an integral part of this "package", delivers up to 8 gpm at 2250 psi, reduces to 6 gpm at 2950 psi and zero flow at 3000 psi. These flow and pressure combinations (8 to 6 gpm range) provide constant horsepower for a variety of flight operating requirements. It is designed for *2000-hour* service.

A centrifugal boost pump is located between the pump and the 400 cycle, 200 v electric motor; in addition to supercharging the pump, it circulates oil through the double-walled motor casing. Cooling oil from the motor jacket is discharged into one case drain port (A) . . . then out port (B) to a heat sink. At full pump flow, the impeller provides 2 gpm to the motor casing.

The 12 horsepower unit described above is typical of the Vickers motor and pump combinations now available to the aircraft industry as "packaged power" for continuous duty applications. Remarkable records for reliability in both military and airline service have been established by Vickers designed motorpumps.

Higher Overall Efficiency

Overall motorpump efficiency (hydraulic power output to electric current input) is 75%. This is possible only because Vickers Piston Pumps have an overall efficiency of 92%. The more efficient pump means the use of a smaller, lighter electric motor, minimum heat transfer to the hydraulic circuit, and less current drain.

Heat Rejection Control

The oil cooled motor design offers a definite advantage in that heat dissipated (140 Btu per minute, maximum) can be conveyed readily to a remotely located heat sink. This is one reason why optimum performance for a given weight and size is more readily achieved in a liquid cooled unit.

High Altitude Operation

Motor operation is not affected by low air density since it is not dependent upon air cooling. Inclusion of centrifugal boost pump prevents piston pump cavitation above 30,000 ft, even though reservoir is vented to atmosphere.

Constant Power Control

The constant horsepower control shown on the above unit is optional, depending on the application. The control maintains constant 3000 psi pressure as flow increases until the electric motor is loaded to its maximum horsepower. Additional flow is then available at reduced pressure to maintain the same horsepower load on the motor. This type of control is particularly advantageous for low force, high capacity (flow) and high force, low capacity applications while staying within the limits of recommended electric motor load ratings.

Packaged Unit

The axial piston pump, centrifugal boost pump, reduction gear and electric motor are all integrated into an exceptionally compact and high-performance package. This concept also permits a high degree of design flexibility to meet individual requirements.

Sound Insulated

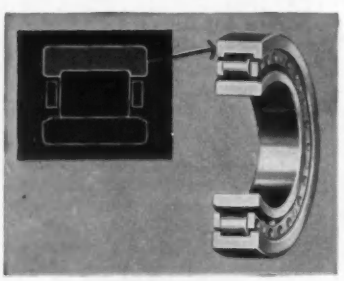
Because air ducts are not needed to dissipate motor heat, the oil cooled motorpump can be sealed in a compartment and effectively sound insulated.

Additional Advantages

Low frictional starting torque characteristics of the 12 horsepower unit permit acceleration to maximum speed in less than 200 milliseconds. The electric motor meets the military specifications for explosion-proof operation.

For further information contact the nearest office listed below.

Loggers' "weight-lifter" tests bearing stamina!



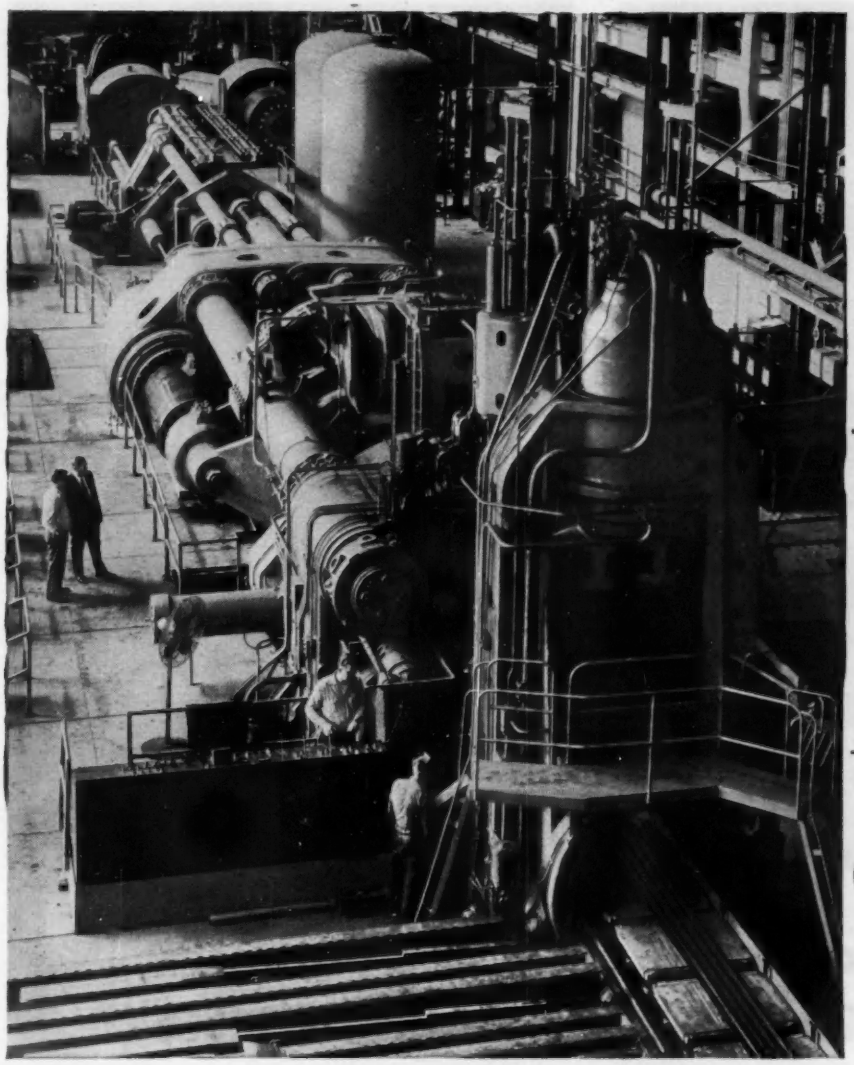
TWO-LIP RACE INCREASES RIGIDITY

Two parallel shoulders made integral with the outer race, as shown in gray above, increase rigidity and durability—keep rollers in proper alignment. Precision-ground rollers and races give quieter, smoother operation.

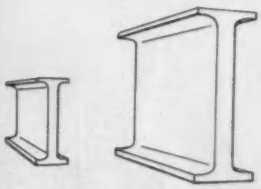
Tossing around logs 6 feet in diameter like toothpicks is no job for a softie! This machine has to be *built* for it right from the start—*right down to the bearings.* And that goes, too, for the trucks which haul these back-breaking giants over the most rugged terrain. Bower tapered and straight roller bearings have been *engineered* for just such work as this—to last longer, perform better under any road or load condition. Painstaking quality control plus basic bearing design refinements—like those shown at left—have reduced Bower Bearing failure to a practical minimum. *Whatever* your product, if it uses bearings, specify Bower! There's a complete line of tapered, straight and journal roller bearings for every field of transportation and industry.

BOWER ROLLER BEARING DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 14, MICHIGAN

BOWER ROLLER BEARINGS

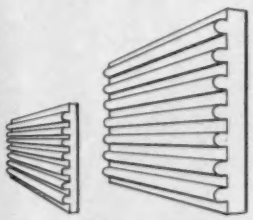


HOW THE 13,200-TON PRESS BOOSTS EXTRUSION CAPACITY



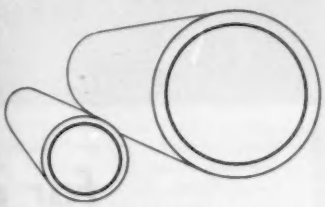
FROM 11" TO 28"

STRUCTURAL SHAPES



FROM 9" TO 20"

STIFFENED SECTIONS



FROM 10" TO 24" O.D.

TUBING

DOW'S NEW EXTRUSION PRESS PACKS 13,200-TON PUNCH

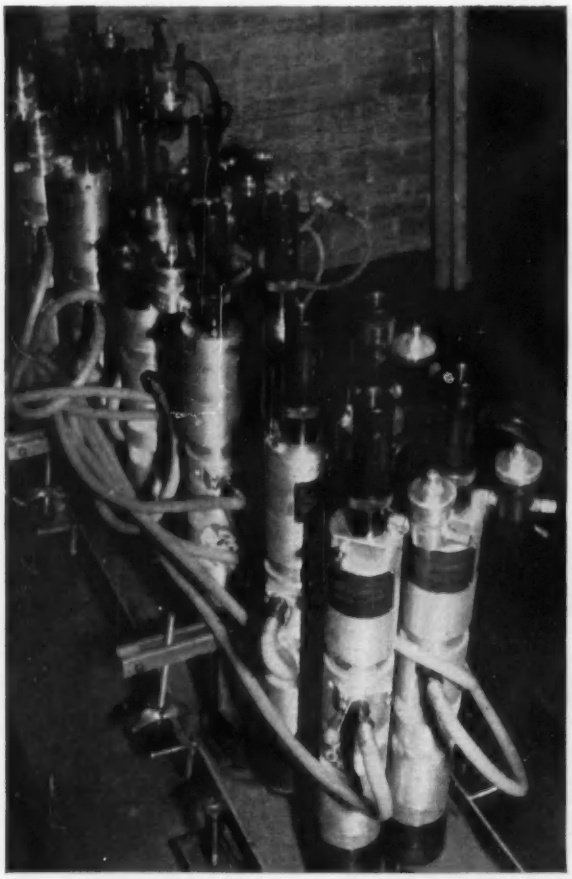
Here's a whole new range of large magnesium extrusions:
24-inch O. D. Tubing 28-inch I-Beams 80-foot-long sections

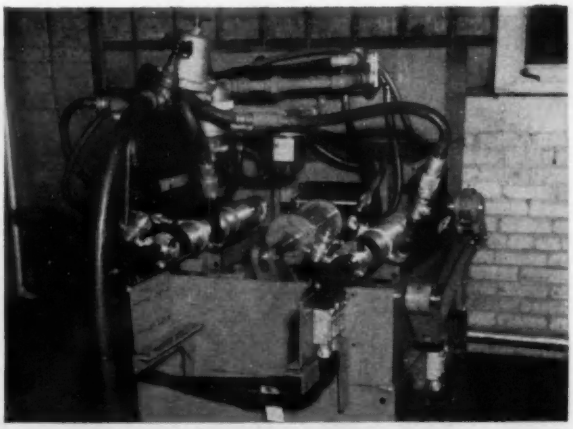
This mammoth press, newest addition to The Dow Chemical Company's rolling and extrusion mill at Madison, Illinois, is the world's largest magnesium extrusion facility. Its vastly increased capacities afford new opportunities for designers working with light metals. A wide variety of new magnesium applications for aircraft, missile, military and general industrial use are now possible and practical. In addition to extruding magnesium, the press is also available for large aluminum extrusions.

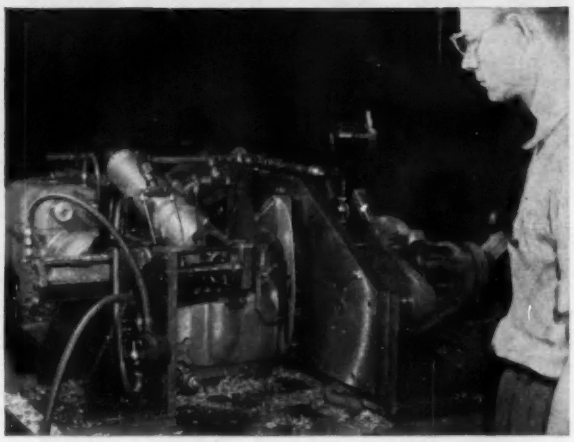
Here's how the big press will increase maximum dimensions of representative magnesium extrusions: Integrally stiffened sections, from 9 to 20 inches wide; I-Beams from 11 to 28 inches high; round tubing from 10 to 24 inches outside diameter; and maximum lengths of 80 feet. A large number of shapes and forms can be produced, limited only by the design of the die through which the metal is extruded. Many complex shapes that formerly required separate operations can now be formed in one operation.

If your design calls for large magnesium or aluminum extrusions, contact the nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1406D.

YOU CAN DEPEND ON DOW





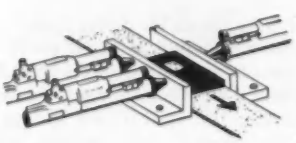


for accurate holes in a hurry

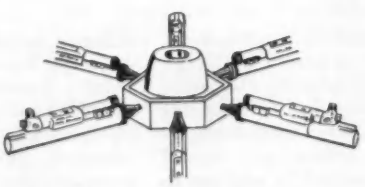
. . . USE KELLER TOOL "AIRFEEDRILLS"®

"AIRFEEDRILLS" are easily adapted to almost any drilling setup. You mount them as a drilling unit of from two to 20 spindles for automatic hole processing. Use one as a stationary drill mounted on an inexpensive fixture. As a portable drill, "AIRFEEDRILL" hangs by its nose to a jig for precision drilling.

If you are drilling, reaming, countersinking, chamfering, counterboring or spot facing, ask your Gardner-Denver representative to show you how a Keller Tool "AIRFEEDRILL" setup can help you save time and cut costs. Or send for bulletins on Keller Tool "AIRFEEDRILL" units and drill bushing tips.



Automatic drilling unit



Stationary drilling

Portable unit

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

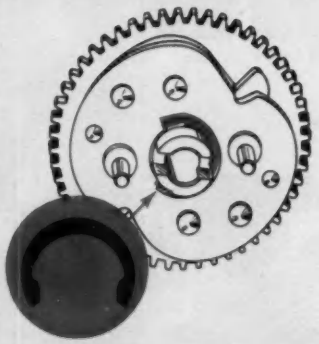
GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

Waldes Truarc Rings speed assembly, facilitate maintenance, improve performance of new automatic calculator

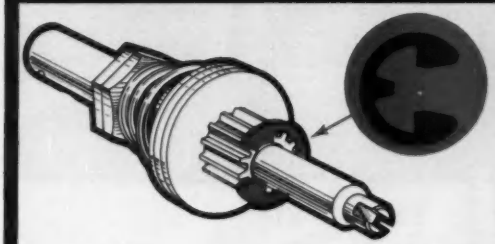
THE NEW MARCHANT DECI•MAGIC

automatic-decimals calculator made by Marchant Calculators, Inc., Oakland, California.

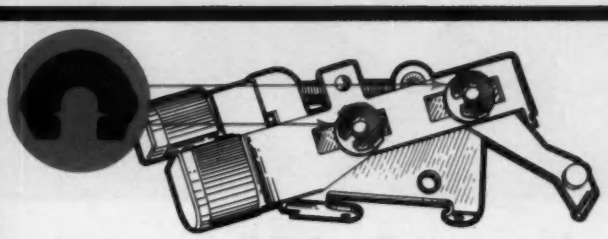


CRESCENT RING SPEEDS ASSEMBLY, DISASSEMBLY

Main clutch utilizes radially-installed series 5103 crescent ring for rapid assembly and disassembly. Ring's low protruding shoulder provides necessary clearance between ring and the two studs. The main clutch operates each time a Deci-Magic control key is depressed.



E-RING SECURES PARTS AGAINST SPRING THRUST. Slip clutch assembly uses Truarc series 5133 E-ring to hold parts on shaft. Functioning of the assembly is dependent upon the ring's ability to withstand thrust exerted by the heavy barrel spring.



LOCKING PRONG RINGS PERMIT SIMPLE DESIGN. Shift slide assembly uses two Truarc series 5139 bowed locking prong rings to lock the parts together in a sliding fit. Precise amount of spring tension prevents objectionable wobble and noise, permits the key to slide smoothly in operation. Easy radial assembly and disassembly of rings facilitates field maintenance and repair. Alternative construction would have required cut washer, spring washer and hairpin-type spring clip on each stud.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

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Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications. *(Please print)*

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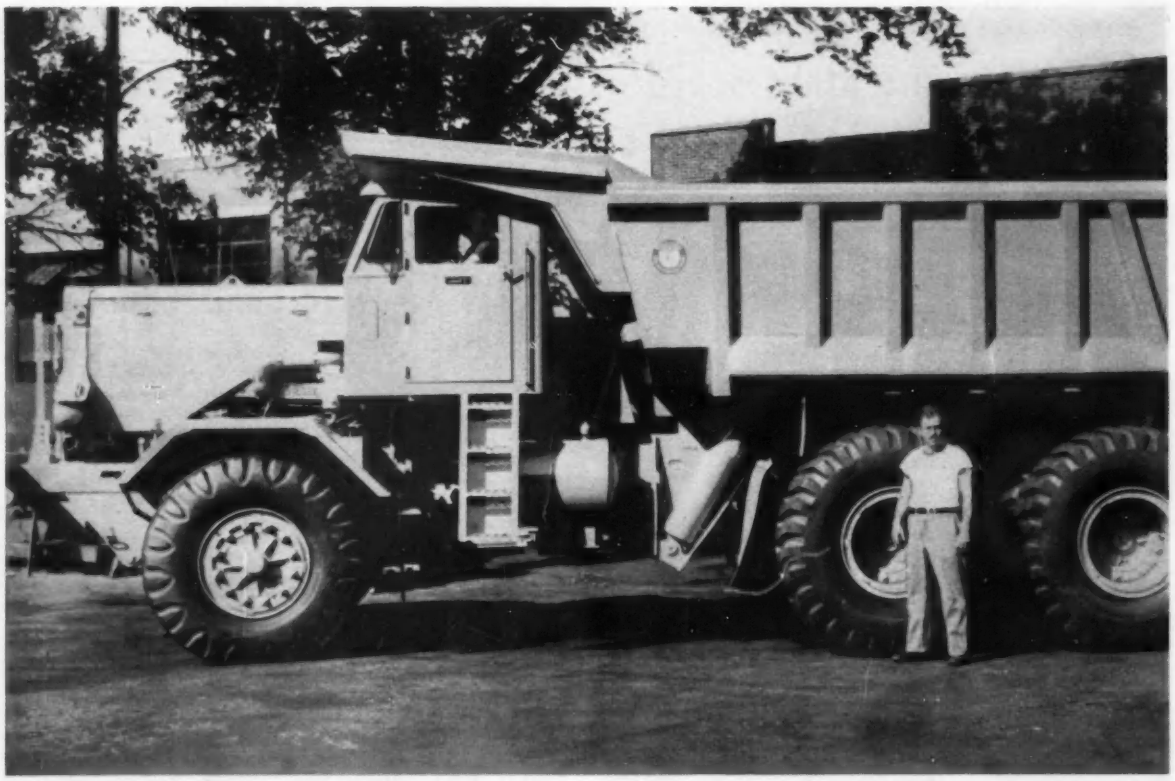
City ..... *Zone* ..... *State* ..... SA 109

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.



Newest Dart 55-ton...

Nickel alloy steels lighten ore carrier axles, absorb terrific loads and impacts

"In 22 years," Dart metallurgists say, "we've found no stronger, tougher axle steels"

This is a real bear cat . . . 55 tons, 25 cubic yards, 400 horsepower.

It's the latest of a long line of heavy-duty, high-capacity Dart trucks.

Like their first model built 22 years ago, it is designed for maximum load capacity and minimum tare weight. And like their first (many of which are *still* in service) its axle shafts are forged of 4340 nickel-chromium-molybdenum steel. They are heat-treated to a hardness of 400/440 Brinell, equivalent to tensile strengths ranging above 200,000 p.s.i.

The housings are alloy steel castings, of approximately Type 4335 composition, heat-treated to provide a minimum tensile strength of 100,000 and yield strength of 85,000 p.s.i.

Dart has never found another steel to equal the 4300 type for heavy-duty axles . . . and they've tried many. Here's what it gives them:

1. Dependable high strength that allows safe designing for low weight.

2. Toughness to resist bone-shaking impact under heavy loads and low operating temperatures.

3. Good machinability at high hardness.

4. Excellent hardenability.

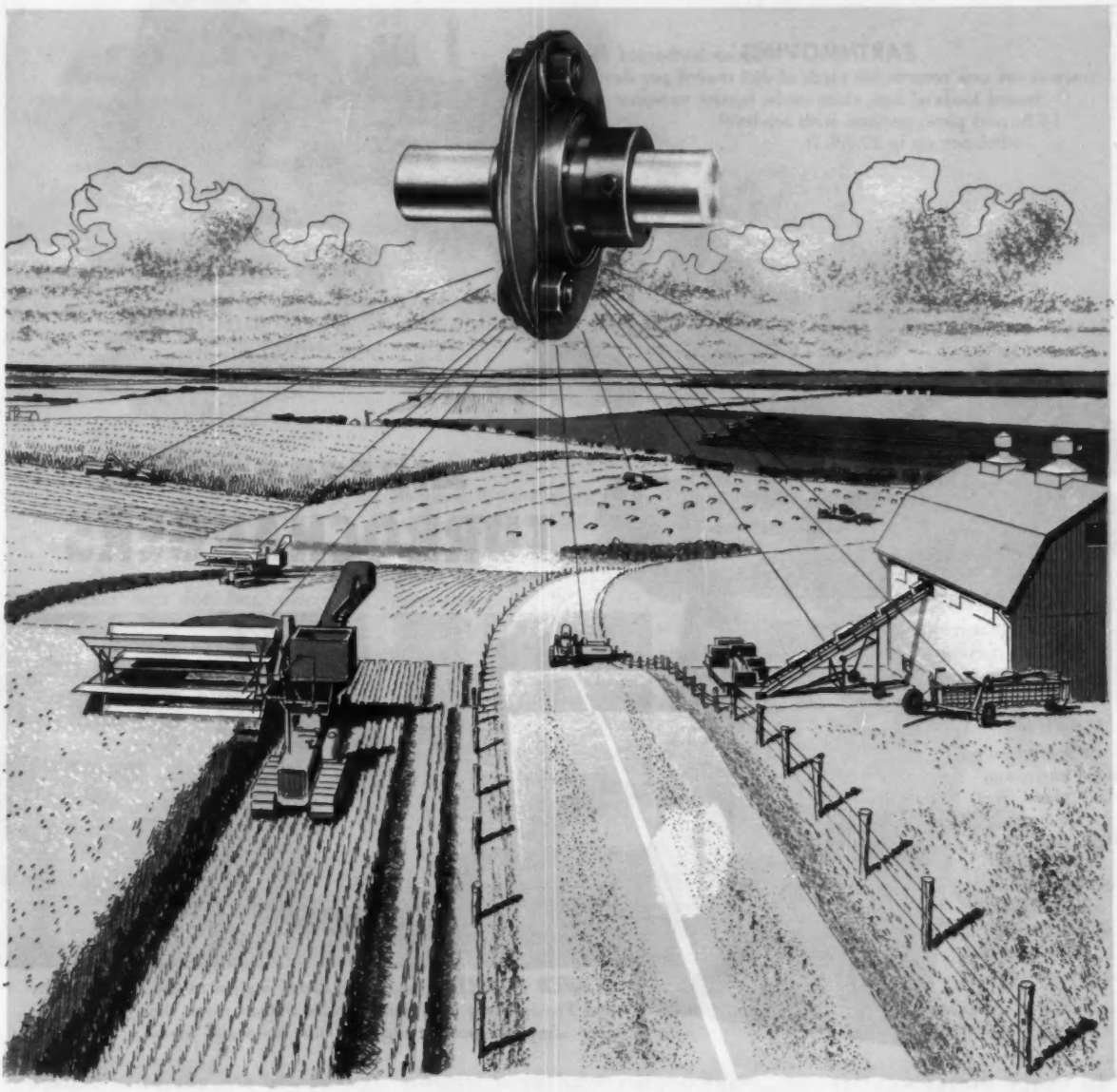
5. Ready weldability along with high strength in cast housings.

Light, strong, easy-to-fabricate. This is the axle assembly for the Dart ore carrier. Housing contains a triple reduction power transmission; wheels, a double reduction carrier and single reduction planetary. To increase the strength/weight ratio and obtain top-notch casting and machining properties, Dart Truck Company, Kansas City, Mo. makes both shaft and housing of medium carbon nickel-chromium-molybdenum steels.

★ ★ ★

Nickel alloy steels are used for dependable trouble-free performance in the most demanding applications. Do you have such a problem in your equipment? Send us the details, we may be able to help you . . . write today.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.



An idea that started the ball rolling for more efficient farm equipment

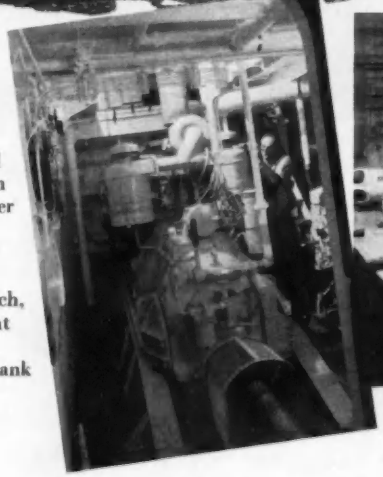
A trend to much wider use of anti-friction bearings on farm equipment was started within the past decade by the Fafnir-originated Flangette, a low-cost, self-contained ball bearing unit. This new idea in completely "packaged" ball bearings broke the cost barrier. It was economical to mount, self-aligning on mounting, and adaptable to many types of applications. Today the Flangette is a standard component on thousands upon thousands of farm machines from conveyors to combines. To satisfy demands for various uses, it is made in three different shapes and equipped with either Plya-Seals (contact-type) or Mechani-Seals (slinger-type). The Flangette is one of several types of Fafnir ball bearing units helping to increase the efficiency and service life of modern farm machinery. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
MOST COMPLETE LINE IN AMERICA
BALL BEARINGS

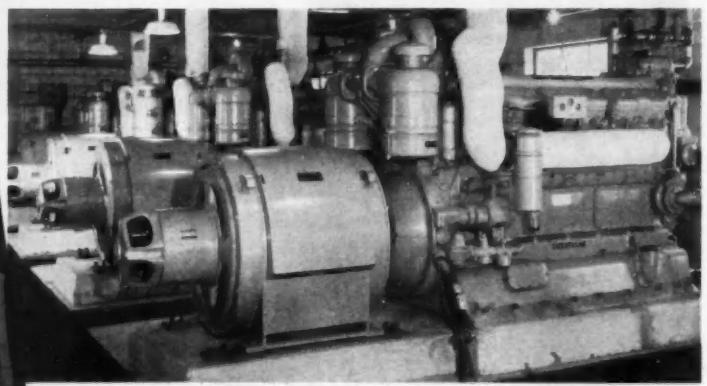
EARTHMOVING turbocharged diesel tractors set new records for yards of dirt moved per day, skid record loads of logs, clear roads, uproot mesquite with 14 ft. root plow, perform with sea-level efficiency up to 12,000 ft.

Caterpillar
built machines
up performance
with

AIRESEARCH TURBOCHARGERS



MARINE turbocharged diesel engines in the inland river towboat, *Papa Guy*, are rated at 490 horsepower each, allow the boat to tow two 20,000-barrel tank barges per trip.



POWER PLANT turbocharged diesel engines at the Barton Light and Power Plant in Vermont raise output more than 25% while decreasing fuel per horsepower hour, noise and smoke.

In every diesel application, AiResearch turbochargers have improved engine performance to an outstanding degree. The exceptional efficiency of their basic design and turbine wheels makes them the finest in the industry.

They provide the following advantages: increased power up to 100% depending on engine design and application; lower specific fuel consumption; lower engine thermal loading and less smoke and noise. AiResearch turbochargers are air cooled, eliminating additional load on the cooling system and also eliminating complicated plumbing. Experience with thousands of units in the field proves their extreme reliability and durability.

• *Your inquiries are invited.*

BASIC SPECIFICATIONS FOR AIRESEARCH TURBOCHARGERS					
MODEL	F-51	C-60	A-60	E-100	B-100
Output — lb/min. (Standard Conditions)	29-51	30-60	38-60	50-100	60-100
Diameter — in. nom.	10.0	11.5	15.25	15.1	15.4
Length — in.	10.5	12.9	16.75	14.7	17.1
Weight — lb.	40.0	95.0	125.0	112.0	135.0

THE GARRETT CORPORATION

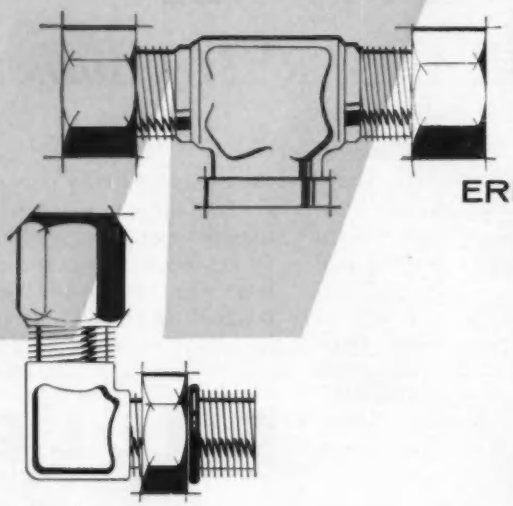
AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS

WEATHERHEAD

steel tube fittings for high-pressure applications

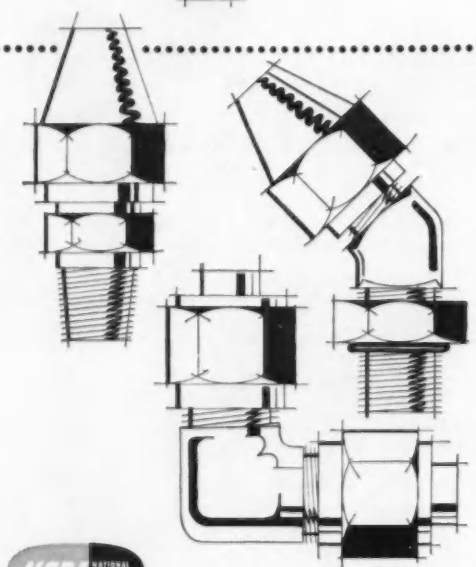


ERMETO®

NO FLARING • NO THREADING
NO WELDING • NO SOLDERING

Steel and stainless steel Ermeto fittings in sizes and types to meet any high-pressure need. Also straight-thread Ermeto fittings to meet new S.A.E. boss specifications.

NOTE—All 7000 Series straight-thread Ermeto fittings and components have corrosion-resistant "Weathercote" finish.

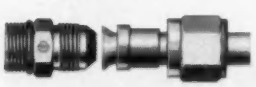


FLARE-TWIN*

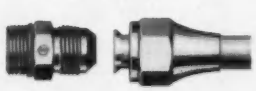
S.A.E. 37° Flare-Twin (J.I.C.) fittings are available with Dryseal-thread or with new straight-thread in popular styles and sizes for S.A.E. "O" ring boss design. Available with cadmium-plate or new corrosion-resistant Weathercote finish.

Trade name for the new Weatherhead 37° flared fitting.

3-PIECE TYPE



2-PIECE TYPE



NFPA NATIONAL FLUID POWER ASSOCIATION

WEATHERHEAD
FIRST IN HYDRAULIC CONNECTIONS

THE WEATHERHEAD CO., FORT WAYNE DIVISION
Dept. AD-10, 128 West Washington Blvd., Fort Wayne, Ind.
In Canada: The Weatherhead Co., Ltd., St. Thomas, Ontario

DELCO HIGH POWER TRANSISTORS

Now available . . .
FOUR new types!
New LOWER prices!

Typical Characteristics at 25° C

	DT100	2N441	2N442	2N443
Maximum Collector Current	13	13	13	13 amps
Collector Voltage, Emitter Open	100	40	50	60 volts
Saturation Voltage (12 amps)	0.7	0.7	0.7	0.7 volts
Power Dissipation	55	55	55	55 watts
Thermal Gradient from Junction to Mounting Base	1.2°	1.2°	1.2°	1.2° °C/watt
Nominal Base Current I_B (V_{EC} = —2 volts, I_C = —1.2 amp.)	-19	-26	-26	-26 ma
Distortion (Class A_1, 10 watts)	5%	5%	5%	5%

Delco Radio offers four new alloy junction germanium PNP transistors to meet an even wider range of applications. Like all of Delco Radio's High Power transistors, these are characterized by high output power, high gain and low distortion. All, too, are normalized to retain their fine performance characteristics regardless of age. Furthermore—these new types are all in volume production. Other types are available at new, lower prices. Data and application sheets and price lists are available upon request.

DELCO RADIO
Division of General Motors
Kokomo, Indiana

Whatever Your Requirements

SPECIFY... # TIMKEN-DETROIT®

Cross-country trucking . . . quarrying . . . logging . . . mining . . . heavy construction . . . whatever your on- or off-highway hauling needs—one of the products in the complete Timken-Detroit line of lightweight, medium and heavy-duty, and planetary tandem driving axles will assure you more productive work time—faster, more economical maintenance . . . smaller parts inventory!

TIMKEN-DETROIT LIGHTWEIGHT TANDEM

gives you greater payload capacity. Up to 700 pounds lighter than any other unit of equal capacity, this new lightweight tandem will give you up to 26,000 extra ton-miles of payload in every 75,000 miles of operation.

TIMKEN Detroit AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted D A Standard
TRADE MARK REGISTERED

for Tandem Driving Axles

Products of

Rockwell Spring and Axle Co.

TIMKEN-DETROIT HEAVY-DUTY TANDEM

with large rugged double-reduction gears is unequaled for dependable, economical operation under toughest conditions. Exclusive "Cradle Ride" suspension, with its long, resilient, floating springs, reduces road shock, stabilizes the load, and improves driver control. Some Timken-Detroit medium and heavy-duty tandems are available with worm drive.

ONLY TIMKEN-DETROIT OFFERS YOU ALL THESE EXCLUSIVE FEATURES AND ADVANTAGES!

Timken-Detroit Inter-Axle Differential divides torque evenly between axles, yet permit wheels of one axle to revolve faster or slower than wheels of other axle. Both axles do equal amounts of work. Driving parts and tires last longer. Controlled from the cab, the differential can be locked out at any speed to give positive through-drive.

Timken-Detroit "In-Line" Propeller Shaft Drive gives you straight-through drive. Bearing and gear life is greatly increased because universal joint working angles are materially reduced.

Unequaled Parts Interchangeability means easier maintenance. Almost all parts in TDA® tandems—gears, pinions, differentials and brakes—are interchangeable with parts from Timken-Detroit standard single axles. This means more productive operation time—fast, simple, economical maintenance, smaller parts inventory.

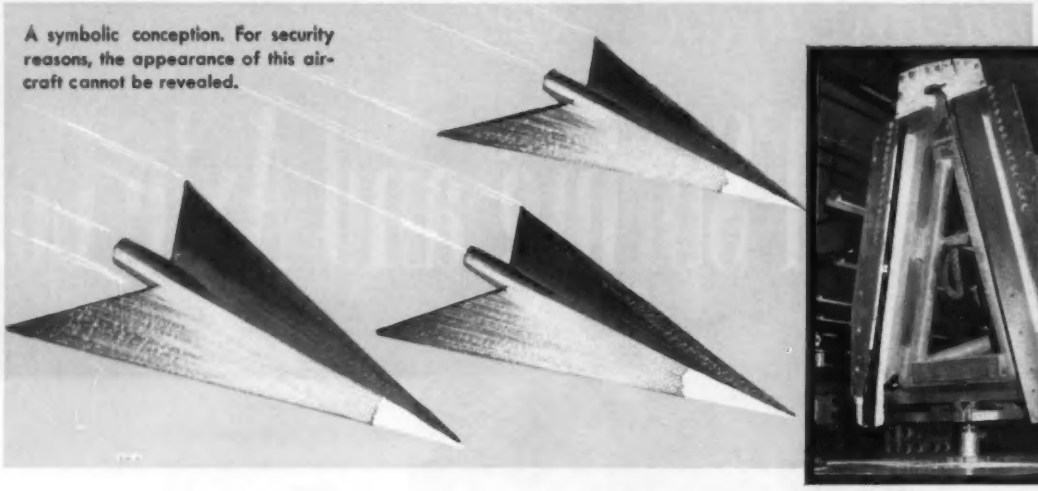
Famous Torsion Flow Axle Shafts are made even stronger through the use of more splines and greater root diameter.

Timken-Detroit Rectangular Shaped Axle Housings are forged from high carbon steel. This shape, plus TDA full strength corner sections, provides greatest strength possible with minimum weight and size.

Timken-Detroit Hypoid Gears with their larger pinions and greater tooth contact give outstanding performance, top efficiency and long life—plus lower maintenance costs.

Dependable Heavy-Duty "P" Series Air Brakes utilize a unit-mounted design to make a compact self-contained assembly. Open type spiders mean lower temperatures, longer liner life. Tapered "Econo-liners" provide greatest thickness in area of greatest wear.

WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS, BUSSES AND TRAILERS



A symbolic conception. For security reasons, the appearance of this aircraft cannot be revealed.

A master drill and setting gauge, showing use of Epon resins to duplicate compound curves and contours.

In building the supersonic Arrow . . .

Avro Aircraft, Limited saves time and money with

EPON® RESIN

dies, tools, jigs, molds and fixtures

Avro Aircraft, Limited—developing Canada's supersonic Arrow—is achieving major savings with Epon resin tooling.

Epon resins provide faster, lower cost preparation of stretch dies, forming tools, drop hammer dies, jigs, duplicate master die molds, checking and assembly fixtures. Avro reports that in making dies of Epon rather than metal, manpower requirements are two-thirds less, which is reflected in correspondingly great savings in the unit cost of tooling.

The Epon resins have an ideal combination of properties for tooling applications. To list just a few:

- Exceptional dimensional stability, high impact strength, excellent resistance to abrasion, minimum residual stress in cured parts.
- Ease and speed of preparation.
- Low shrinkage in filled formulations, assuring perfect master reproduction; minimum warping and stresses.
- Adaptability to repairs and design changes.
- Minimum finishing requirements for smooth surfaces.

Like Avro, other leading manufacturers report savings as high as 80% with Epon resin tools and dies—for *production* as well as experimental and short-run work. Can you make comparable savings in your own operations? Find out by writing for technical literature on Epon resins for tool and die applications.

Epon-faced die requires only hand rubbing to achieve smooth finish. Radii are being touched up with sander.

Stretch die, with Epon resin facing of involved contours, ready for run on 800-ton press.

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SHELL

Why designers specify FLEXLOC self-locking nuts

Where products must be tough . . . must stand up under vibration, shock and abuse . . . designers specify rugged, reliable, precision-built FLEXLOC self-locking nuts as fasteners.

HERE'S WHY:

FLEXLOC locknuts are strong: tensile strengths far exceed accepted standards. They are uniform: carefully manufactured to assure accurate, lasting spring tension in the flexible locking collars. And they are reusable: rough screw threads, repeated removal and replacement, frequent adjustments will not affect their locking life.

Standard FLEXLOC self-locking locknuts are available in a wide range of standard sizes and materials, to meet the most critical locknut requirements. Your authorized industrial distributor stocks them. Write us for complete catalog and technical data. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 55, Pa.

We also manufacture precision titanium fasteners. Write for free booklet.

FLEXLOC® LOCKNUT DIVISION

STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA

cool metal for hot planes

For jet and rocket aircraft engines, wings and surfaces that are subject to extreme conditions of heat, friction and corrosion, where the metal *must stand up* . . . design it, improve it and protect it with McLOUTH STAINLESS STEEL.

specify

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HIGH QUALITY SHEET AND STRIP

for aircraft

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MANUFACTURERS OF STAINLESS AND CARBON STEELS

Whatever the cargo or job— these fleets . . .

Photo courtesy of Gerlinger Carrier Co.

Photo courtesy of the White Motor Co.

roll up steady profits with dependable

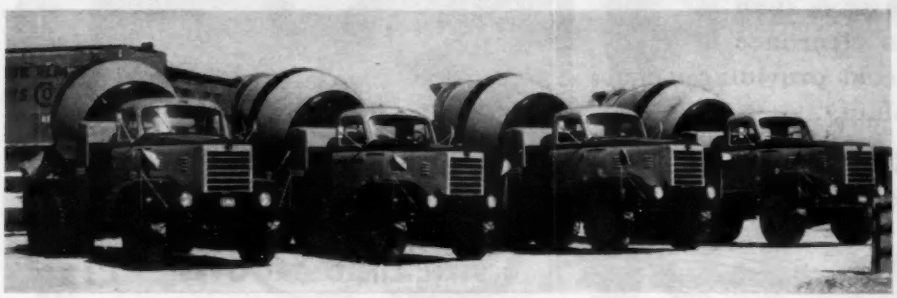

Photo courtesy of the Four Wheel Drive Auto Co.

BLOOD BROTHERS Propeller Shafts

Here are fleets of three kinds . . . each specialized for its purpose. But all three have one advantage in common. They're all equipped with rugged, dependable Blood Brothers Propeller Shafts.

The reason is simple. Blood Brothers Propeller Shafts have proved they will deliver maximum engine torque smoothly—and give outstanding trouble-free service year-after-year.

Seldom requiring attention, they make a hit with profit-minded fleet owners. So—whether you build trucks or operate them—you can depend on Blood Brothers Propeller Shafts to help keep down-time *down* and fleet earnings *up!*

Write now for specific data—we'll gladly cooperate.

BLOOD BROTHERS MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
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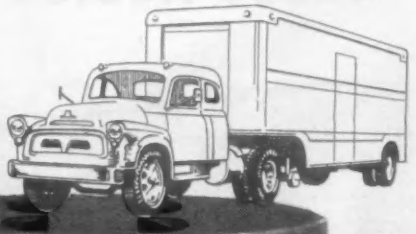
UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

Rapidly becoming the

Standard of the Automotive Industry



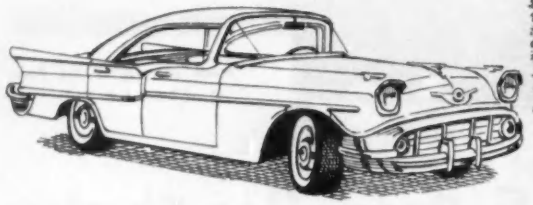
INCREASES ENGINE LIFE UP TO 400%

STERLING'S great "Conformatic" piston with "Intra-Cast" steel ring groove liners give sensationally longer life to rings and grooves—

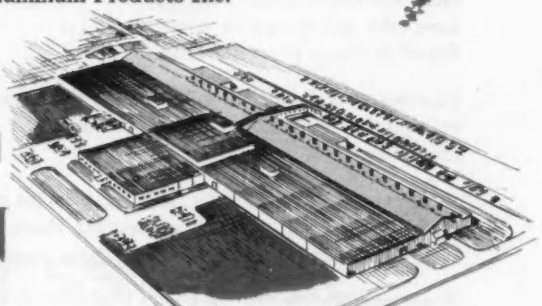
Recommended clearances for "Conformatic" pistons are from 0 to ½ thousandth inch. This clearance is maintained hot and cold providing unbelievable bore stability.

STERLING'S CONFORMATIC PISTON WITH INTRA-CAST STEEL LINED GROOVES

prevents frictional horsepower loss, reduces oil consumption to an absolute minimum, and prolongs engine life up to 400%. *Intra-Cast* and *Conformatic* are registered trade names of STERLING Aluminum Products Inc.



Sterling's revolutionary *Conformatic* piston already has been accepted and is now being used in a number of America's finest and most popular passenger cars.



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120 acres! Completely new automated plant at the confluence of the Missouri and Mississippi Rivers

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ALUMINUM PRODUCTS INC.

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Custom-Engineered to Your Requirements

Dependability, performance, creative engineering . . . keys to initial and repeat orders for any manufacturer. They are the same reasons why so many leaders in American Industry call on U.S. AXLE to fill their current needs, and help them design for the future.

U.S. Axle Shafts are custom-engineered to your specifications. Made from the finest heat-treated, alloy steels—U.S. Axles are also shot-peened to make them up to *5 times tougher!* Use the advantages of U.S. Axles to improve *your* product's performance.

Send us your blueprints and specifications for prompt quotations on your requirements.

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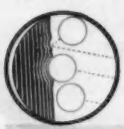
THE US AXLE COMPANY, INC.
Since 1920 • Pottstown, Pennsylvania



SHOT-PEENED to make them up to **5 TIMES TOUGHER**

VALUABLE BROCHURE FREE
Shows you why U.S. Axle is your best source for precision-made special shafts.

THE U. S. AXLE COMPANY
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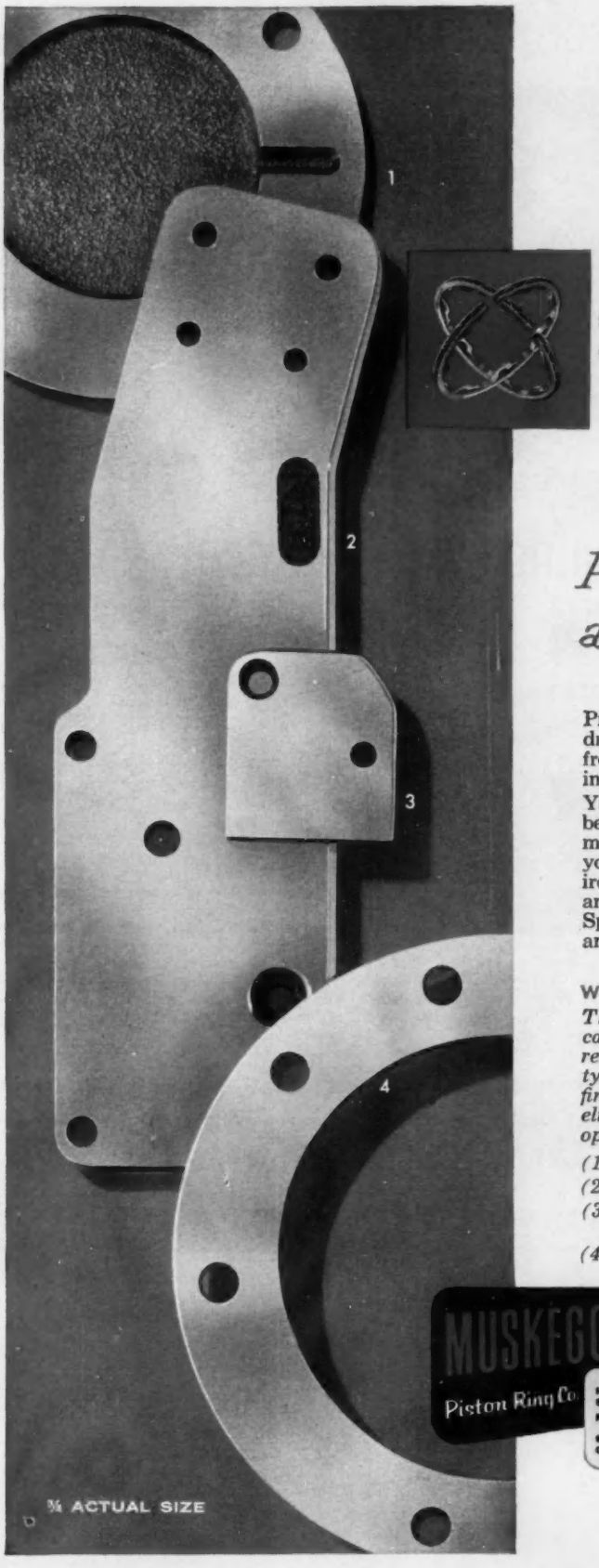


From the producer of piston rings used in 1 out of every 3 new cars . . .

Ready to install castings at "captive cost"

Precision castings—surface finished, deburred, drilled, reamed or tapped—are now available from Muskegon's Sparta Foundry—at surprisingly low cost!

Your exact ready-to-install specifications can be met: width tolerances to within plus or minus .001"; surface finishes and flatness to your specifications. Choice of high carbon cast iron, high strength alloy cast iron, cast bronze and sintered powdered metal parts—plus special Spartaloy metals to meet unusual heat, wear and corrosion problems.

WRITE FOR YOUR FREE SAMPLE KIT

This miniature assortment shows how cast-in holes, recesses and projections can reduce machining costs. Some typify how Sparta's complete finishing and machining eliminate these operations for you. Write today!

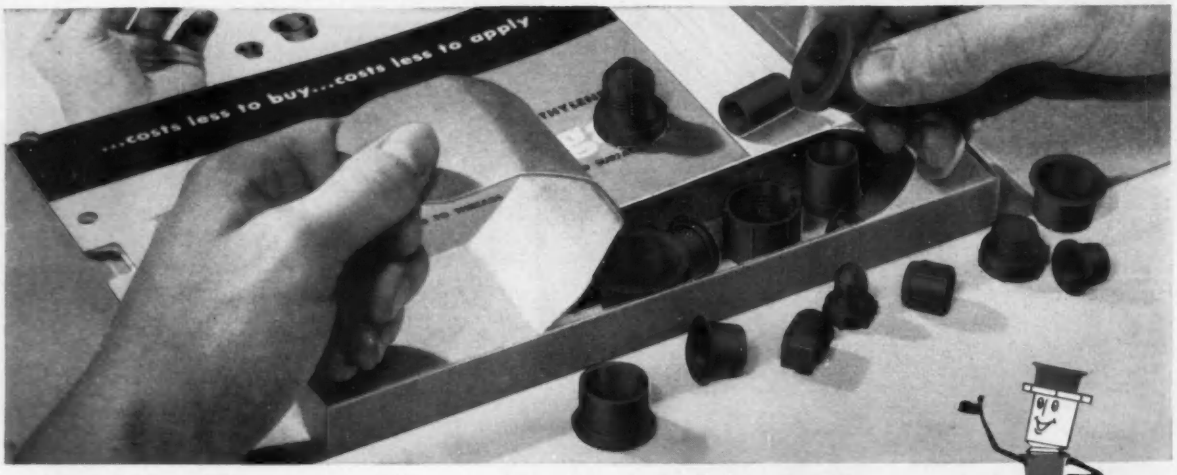
(1) Countershaft bearing cover.
(2) Air valve adapter plate.
(3) Automatic transmission governor cover plate.
(4) Countershaft retaining ring.

MUSKEGON Piston Ring Co.

PLANTS AT MUSKEGON, MICHIGAN SPARTA, MICHIGAN ROTARY SEAL DIVISION PLANTS AT SPARTA, MICHIGAN CHICAGO, ILLINOIS

Since 1921... The engine builders' source!

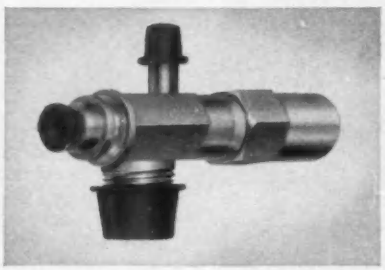
which **CaPlug** will protect <u>your</u> product best?



write for this free sample kit and see!

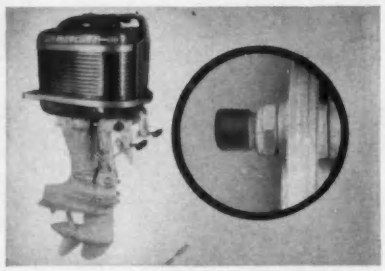
WANT TO SEAL OPENINGS IN A JIFFY?

Tapered (non-threaded) CaPlugs can be used as caps or plugs, inside and outside of threaded or plain fixtures. Just push them on . . . or push them in. Costing less to buy, these versatile closures cost less to apply. Time studies show that tapered CaPlugs save up to 500% in labor costs.



WANT TO KEEP FITTINGS UNDER WRAPS?

See how CaPlugs seal out dust and protect fittings of this refrigeration valve during shipment. Says Automatic Machine Products Sales Co., "It is important that the valve be free from contamination, since a large percentage of refrigeration systems are hermetically sealed and guaranteed for five years. CaPlugs are easy to install and afford the protection we desire."



WANT TO PROTECT DELICATE THREADS?

Kiekhaefer Corp. guards the threads on the "Ride Guide" steering controls of its Mercury outboard motor with *threaded style* CaPlugs. Here's long-lasting protection . . . the customer can reuse the CaPlugs when storing his motor. Made of tough, flexible Polyethylene, CaPlugs are especially kind to threads and polished surfaces — will not collapse, chip, break or shred.

WANT TO ADD SALES APPEAL?

Colorful CaPlugs spruce up your product and reflect the care you have taken to keep delicate systems free of dirt, moisture or foreign matter. This Bristol air control instrument is a good example. Says The Bristol Company, "They are sturdy enough so that they are not accidentally dislodged, but are still easily removable."

CAPLUGS FIT PRACTICALLY ANY CLOSURE NEED YOU CAN NAME.

Ten standardized designs (both threaded and non-threaded) are stocked in over 500 sizes to give you low-cost protection for tubing, fittings, valves, hydraulic components and machined parts of every description. Your immediate requirements can be met promptly with "off-the-shelf" deliveries from a multi-million inventory.

MAIL THIS COUPON FOR FREE CAPLUG SAMPLE KIT WITH DESCRIPTIVE LITERATURE AND PRICES

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RUSH a free CaPlug sample kit, literature and prices to us, without obligation.

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In cramped quarters — where starts, stops and reverses are frequent — loads heavy and torque requirements severe — amid dust and moisture — MECHANICS Close-Coupled, Roller Bearing UNIVERSAL JOINTS serve dependably, safely and economically.

They perform equally well in other rugged machines where joint space is limited and angles are extreme. Let MECHANICS engineers help with *your* joint problems.

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MECHANICS

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For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

New Bendix SM-E Connector

(smaller, lighter than AN-E but equally dependable)

Here is the newest in the ever growing family of Bendix* environment resistant connectors. The new SM-E Series (Short "E") will provide the same performance as the standard AN-E connectors, but is shorter, lighter and more easily serviced. Not only does this connector conform to the vibration resistant requirements of the "E" connector in the MIL-C-5015C government specification, but it also provides effective moisture barriers both at the solder well ends and mating surfaces using the full range of wire sizes. Of particular interest to production and maintenance people is the back nut design, which provides a jacking action on the grommet during disassembly, thereby lifting it free of the solder wells. This feature when combined with the new Bendix "slippery rubber" grommets makes easy work of wire threading and grommet travel over the wire bundles.

Available in all standard AN shell sizes and tooled for most of the popular AN configurations.

Write for complete descriptive folder.

*TRADEMARK

Comparison based on size 40 mated assemblies. Space savings for smaller sizes are proportional.

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Specify Vellumoid Materials for a perfect seal!

THE VELLUMOID COMPANY
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FOR SALE

Two Slightly Used Free Piston Compressors

Two slightly used foreign make free piston compressors: One Sigma Type P13, Serial Number 13C1239, which develops 210 CFM at a frequency of 700 cycles per minute. $5,000 net, f.o.b. Milwaukee, Wisconsin. Terms net 30 days.

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Both units have had approximately 200 hours of carefully supervised indoor test operation and are in good operating condition. **Reply to Box 184, SAE Journal, 485 Lexington Ave., New York 17, N. Y.**

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WITTEK has the answer

Auto Clamp Type GM Sure-Tite

Here's a selection from among the many different types and sizes of hose clamps designed and manufactured by Wittek (leader for over a quarter century). Let Wittek solve *your* clamping problems. Write today.

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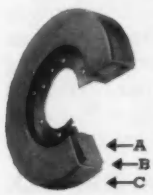
REDUCE CRANKSHAFT VIBRATION

. . . in Diesel Engines

with a HOUDAILLE TORSIONAL VIBRATION DAMPER



A Inertia mass or flywheel
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C Hermetically sealed housing

THE SHEARING ACTION of highly viscous fluid, used exclusively in the Houdaille damper, makes it the *most practical, most efficient* method of reducing torsional vibration in diesel engine crankshafts. A true damper and not a detuning device, it is effective across the full range of engine criticals. To diesel and gasoline engine manufacturers, it offers greater horsepower and speed... to diesel engine users it means smoother operation, longer life and less maintenance.

OTHER OUTSTANDING HOUDAILLE DEVELOPMENTS INCLUDE...

HOUDAILLE FRICTION SNUBBERS

Designed for use on freight and passenger car trucks, to control excess vertical movement and help protect lading on uneven tracks and curves.

HOUDAILLE ROTARY SHOCK ABSORBERS

Engineered and built to outlast and outperform linear type shock absorbers. Available in a wide range of designs, for original equipment or replacement use on railway passenger cars, motor trucks, buses, tractors and farm equipment, and other heavy duty vehicles. Exclusive external valve adjustment... easy to service without being removed.

EXPERIENCED ENGINEERS

and precision production facilities at Houdaille are at your service for any application involving hydraulics. Write Department SAE for specifications and performance data on Torsional Vibration Dampers, Rotary Shock Absorbers or Friction Snubbers

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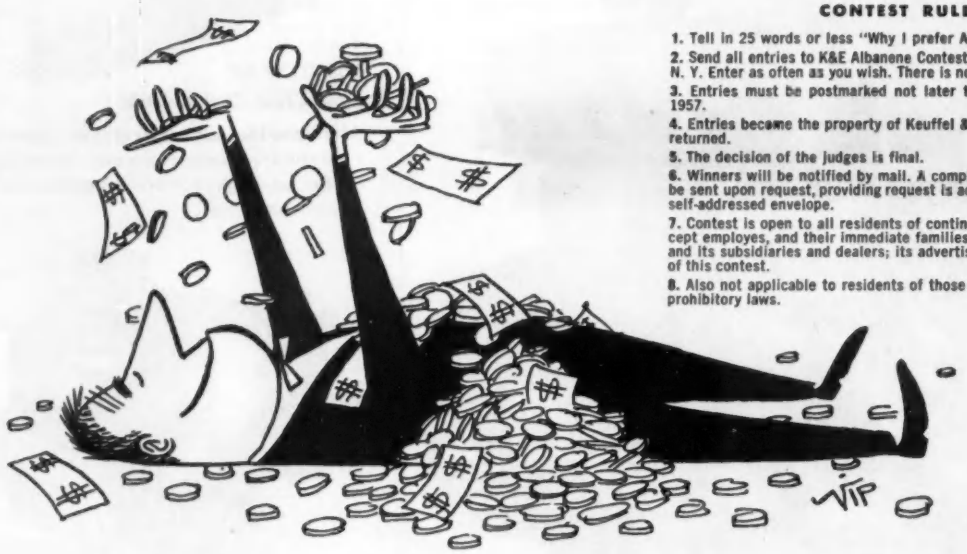

CONTEST RULES

1. Tell in 25 words or less "Why I prefer Albanene tracing paper."
2. Send all entries to K&E Albanene Contest, Box 160, New York 46, N. Y. Enter as often as you wish. There is nothing to buy.
3. Entries must be postmarked not later than midnight, Nov. 30, 1957.
4. Entries become the property of Keuffel & Esser Co. None can be returned.
5. The decision of the judges is final.
6. Winners will be notified by mail. A complete list of winners will be sent upon request, providing request is accompanied by stamped, self-addressed envelope.
7. Contest is open to all residents of continental United States, except employes, and their immediate families, of Keuffel & Esser Co. and its subsidiaries and dealers; its advertising agency; and judges of this contest.
8. Also not applicable to residents of those states where there are prohibitory laws.

Why I prefer **ALBANENE**® Tracing Paper...

First prize **$1500**
Second prize **$1000**
Third prize . . . . . **$ 500**

plus 87 prizes of $25 each!

In 25 words or less, tell us why you prefer K&E Albanene® tracing paper. Your reasons may win one of these 90 prizes (it's K&E's 90th anniversary).

Here's a hint: Albanene is made from 100% rag stock for superlative tear strength. It is permanently transparentized with an inert resin. Draftsmen like it because of its easy drawing qualities... reproduction men for its high transparency and permanence. Everybody likes it because "what you pay for stays in the paper." That's why Albanene is the best seller among *all* tracing papers.

Get contest aids from your K&E dealer: Information booklets, extra contest entry blanks, samples of Albanene, too, if you need them. You can enter as often as you please.

Or use a plain sheet of paper if someone's already snipped the blank below. Give your name, address, and firm name, twenty-five words or less telling why you prefer Albanene tracing paper, and mail to K&E Albanene Contest, Box 160, New York 46, N. Y. before midnight, November 30, 1957.

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New York, Hoboken, N. J., Detroit, Montreal, Chicago, St. Louis, Dallas, San Francisco, Los Angeles, Seattle.
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...as EVANS HEATERS

are right for trucks !

Tough jobs call for the right equipment. Heavy snow can't be cleared with a shovel and broom, and a truck can't be adequately heated by a heater built for passenger cars.

Evans heaters are right for trucks because they're built for trucks. They have the same rugged dependability you build into your trucks . . . the same high standards of manufacture that guarantee peak performance and low maintenance costs. The heaters Evans engineers design and custom-build for you will meet all your truck requirements. Our engineers will be glad to call and discuss your heater problems for any truck model, present or future. For information write Evans Products Company, Dept. Z-10, Plymouth, Mich.

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EVANS HEATERS ARE RIGHT FOR TRUCKS BECAUSE THEY'RE BUILT FOR TRUCKS

EVANS PRODUCTS COMPANY ALSO PRODUCES:
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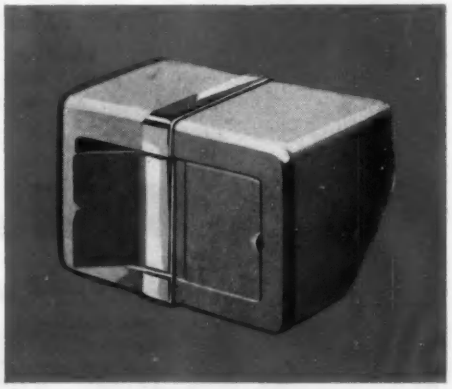
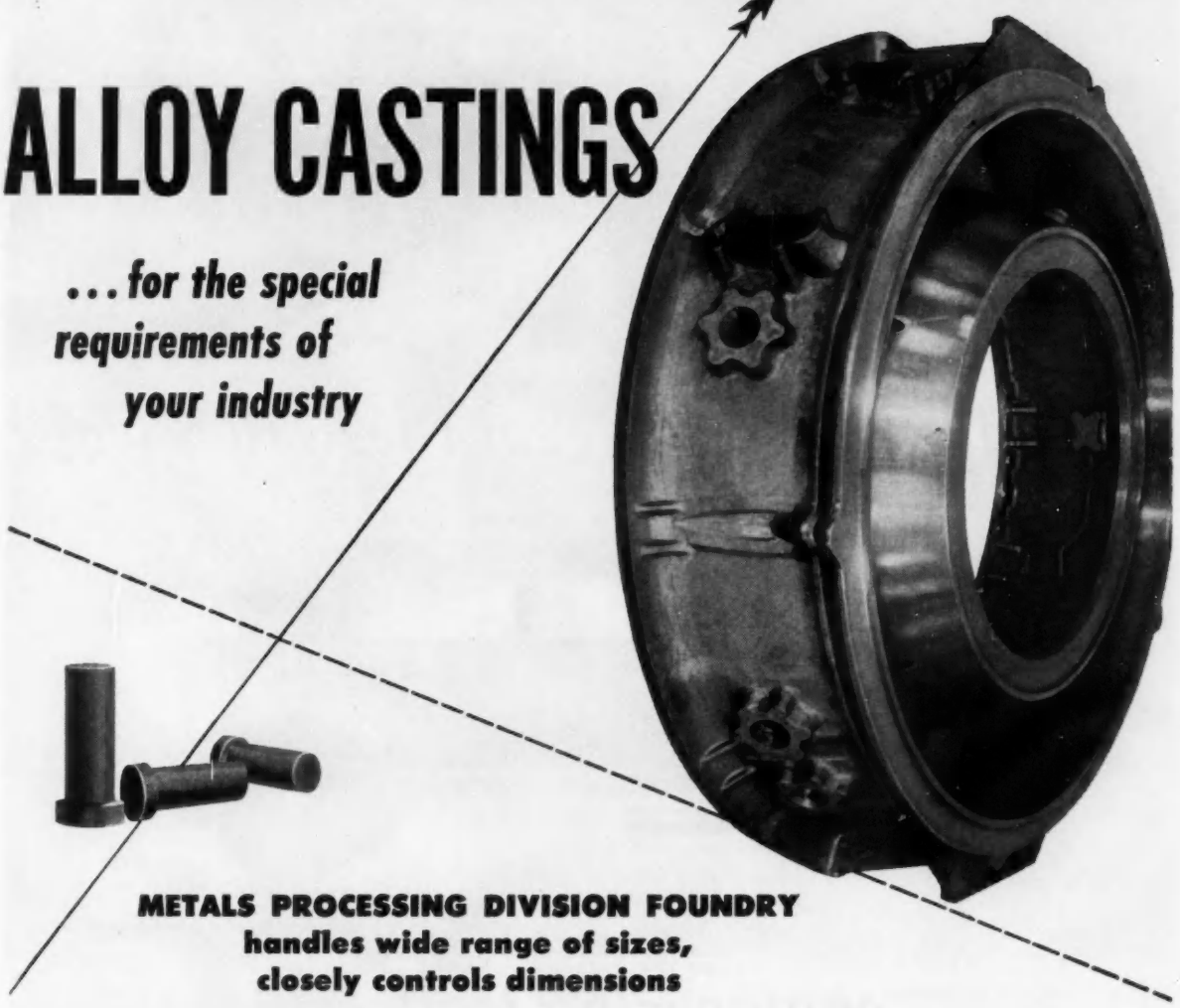


AIRCRAFT QUALITY

ALLOY CASTINGS

...for the special requirements of your industry



METALS PROCESSING DIVISION FOUNDRY handles wide range of sizes, closely controls dimensions

Precision testing methods provide close control of casting quality

Curtiss-Wright's Metals Processing Division today offers your industry precision castings of critical parts in a wide variety of sizes, and with closely controlled dimensions. For example, in the large casting shown, tolerance is ±.030 over 36″ diameter. From its modern, completely equipped foundry in Buffalo, the Division supplies heat, corrosion and abrasion resistant castings from a full range of special-property alloys, including ductile iron... by sand, centrifugal, ceramic or shell processes.

Precision alloying techniques, modern melting controls with spectrometer testing, X-ray control by experienced radiographers — all add up to castings with superior physical and mechanical properties . . . mean better and more dependable products for the critical needs of industry. Qualified design engineering assistance is a part of the comprehensive Metals Processing Division service. Write for details.

77 GRIDER STREET

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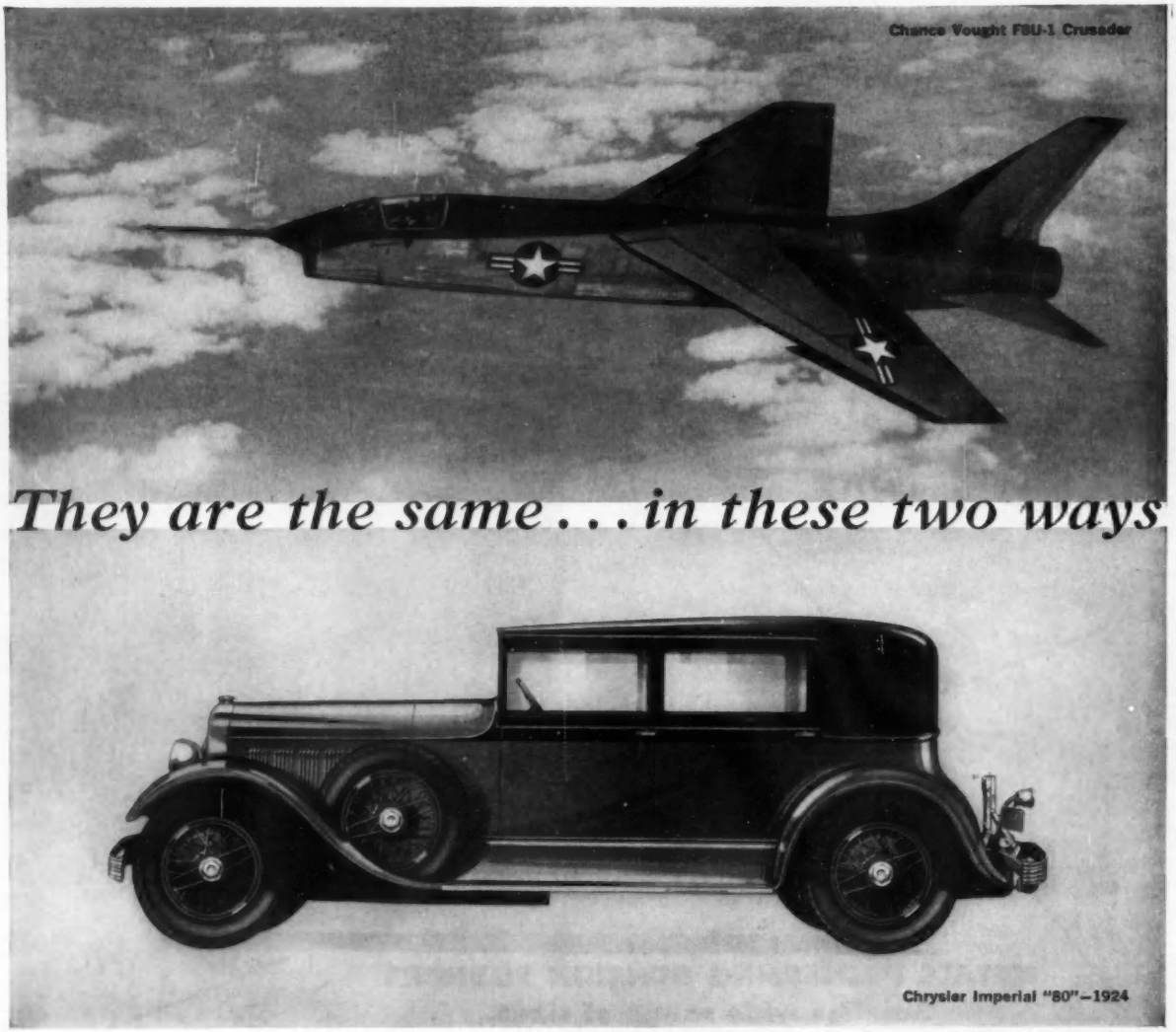

. . . engineering leadership and filtration by Purolator!

Thirty-four years ago, that Chrysler came off the assembly line equipped with something entirely new: an oil filter. By 1956 when the Chance Vought F8U-1 Crusader shattered the national speed record, filters were accepted as basic components on all automobiles and aircraft. Both events were milestones – both vehicles were protected by Purolator.

The 1924 Chrysler seems a relic of another age, while the Crusader is as new as tomorrow. But the concept that got its start with the Chrysler has become fundamental everywhere . . . any fluid – be it air, fuel, lube oil, hydraulic fluid or anything else—which is vital to the proper operation of any aircraft, automobile or machine, must be filtered to be kept free of contamination.

Purolator makes filters for every fluid known to man—for use in any conceivable application. The unique background of specialized know-how enables them to produce the best possible filters for the specific needs of the automotive industry – no matter what they are or when they arise.

Filtration for Every Known Fluid

PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

ROADBUILDING EQUIPMENT sets the pace for modern highway construction. It is exposed to all kinds of weather, needs the positive protection offered by the Granodine coating and the paint finish it so tenaciously bonds to the metal.

ACP Granodine® ANCHORS THE FINISH

ON FARM AND CONSTRUCTION EQUIPMENT

FARM EQUIPMENT, TOO, must be protected under good and bad weather conditions. ACP Granodine phosphate coating under paint affords this extra needed protection.

Weather, dirt and abrasion are archenemies of farm and construction equipment. To protect the metal, a durable and tenacious paint finish is required. ACP Granodine provides the base for such a finish. It chemically converts steel surfaces to a nonmetallic phosphate coating. This base not only increases the adhesion of the finish, but also greatly improves the corrosion resistance of the finishing system even when used in conjunction with a relatively thin and flexible paint film. ACP Granodine coatings are economically applied to steel surfaces by dipping, spraying or brushing.

TRUCKS AND TRACTOR-TRAILERS work night and day all year round. Ice and snow, rain and heat attack the paint finish. ACP Granodine anchors it.

LEARN ALL ABOUT ACP GRANODINE. Bulletin 1380 describes the various types of ACP Granodine and gives information which will help you select the proper type for your particular application. Write for your copy today.

AMERICAN CHEMICAL PAINT COMPANY, Ambler 36, Pa.

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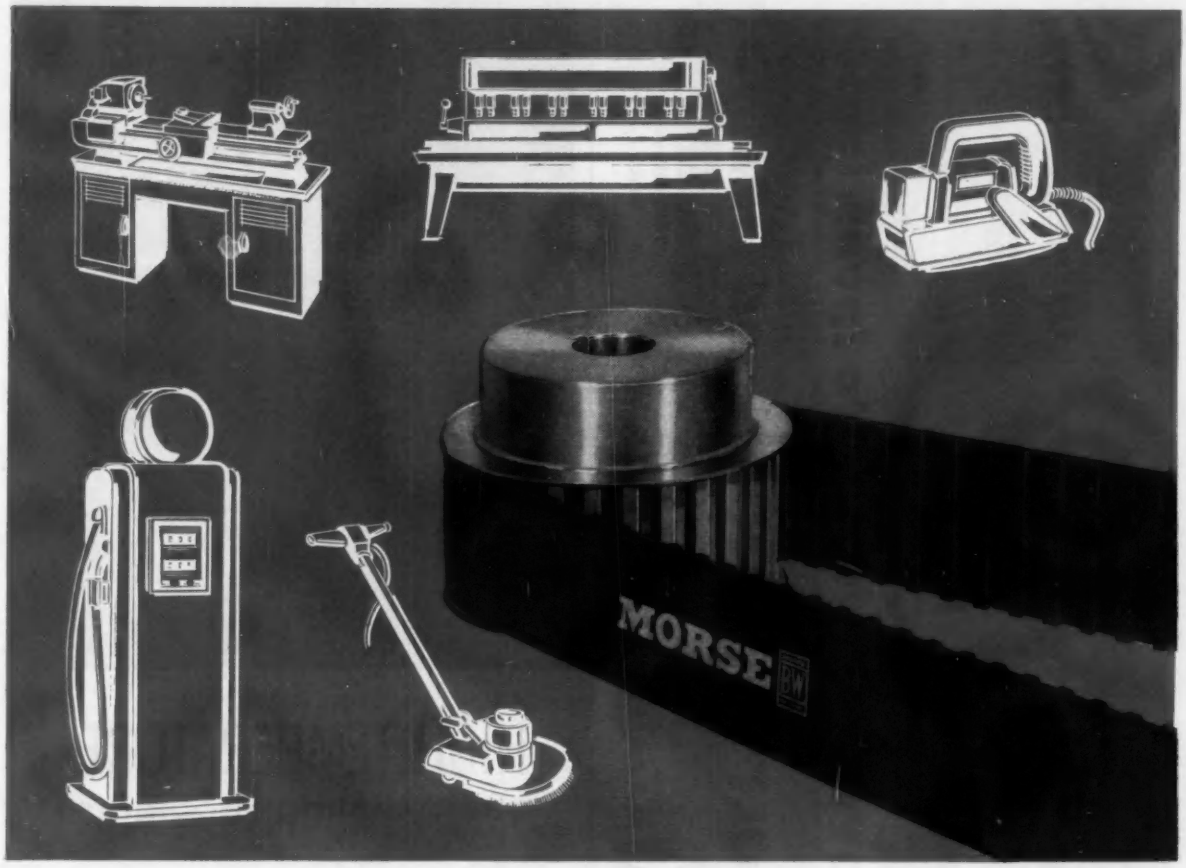
New Chemical Horizons for Industry and Agriculture



New! . . . from Morse Chain

Morse "Timing®" Belts

Stronger, lighter, slip-proof drives from the longtime leader in power transmission!

EXCLUSIVE!

Only Morse offers all 4 of these basic power transmission drives: Roller Chain, Silent Chain, Hy-Vo Drives, and "Timing" Belts. Your Morse distributor has no ax to grind in favor of one or two types of drives—he gives you a truly impartial analysis of your power transmission problems. Call him today!

Here's why *Morse* "Timing" Belts are important to *you:* For the first time, you can get these versatile, job-proved drives from a specialist with years of experience in every phase of mechanical power transmission!

Along with seasoned engineering know-how, Morse gives you the convenience of a complete line to choose from: 0-16,000 FPM; 1/1000 HP to 1,000 HP; in stock or made-to-order drives.

Whether or not you already use timing belts, it will pay you to get all the facts on *Morse* "Timing" Belts from your local Morse distributor. You'll find him listed in the Yellow Pages under "Power Transmission," or write: *MORSE CHAIN COMPANY, DEPT. 12-107, ITHACA, NEW YORK. Export Sales: Borg-Warner International, Chicago 3, Illinois.*

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

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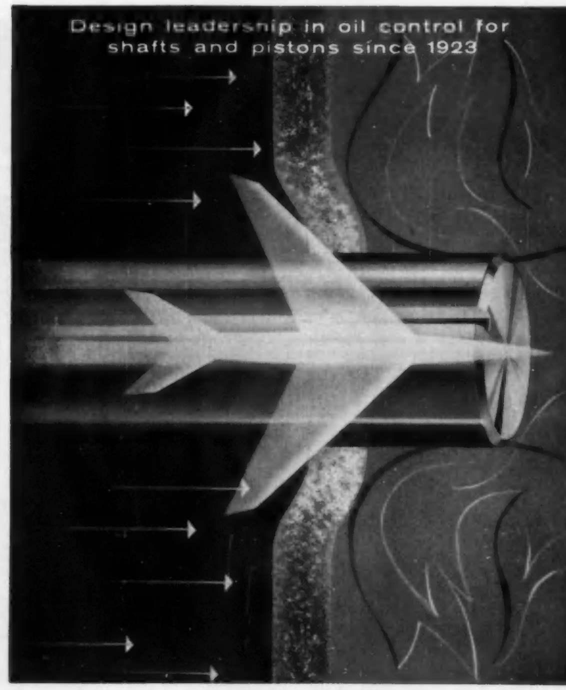

HIGH TEMPERATURE
shaft sealing problems?

...solve them with SIMPLEX

High temperatures and high speeds call for a high degree of cooperation in shaft seal design.

SIMPLEX offers this cooperation in design, backed by wide experience in solving similar problems for leading manufacturers of aircraft engines and auxiliaries. SIMPLEX products are supplied as original equipment in Allison, Pratt & Whitney, Wright and other leading aircraft engines.

If the problem involves shaft seals or piston rings, whether for jet or reciprocating engines or components, call for the specialized help that SIMPLEX engineers can offer. Call, wire or write.

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SIMPLEX
HIGH SPEED SHAFT SEALS AND PISTON RINGS

+ INDEX TO ADVERTISERS +

New resilient clutch facings operate at 400 psi or higher

A new group of resilient friction materials that operate at closing pressures of 400 psi and ambient temperatures up to 315° F. has been developed by Armstrong research engineers.

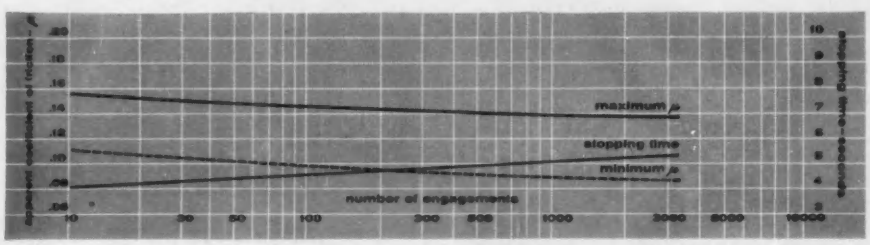
These new materials meet the demands of modern automatic transmissions where increased engine horsepower and design changes have combined to impose sharply higher loads on clutch facings.

The new compositions are made by an entirely new patented process that combines inorganic and organic fibers with synthetic saturants. The new materials have high capacity and show virtually no change in coefficient of friction during their long service life.

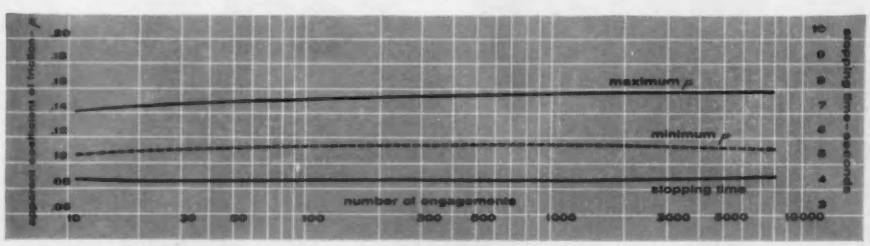
Although designed for use at ambient temperatures of 315° F., the new materials are not affected by the much higher flash temperatures often encountered during severe engagement. They have been operated in some experimental transmissions at closing pressures as high as 2,000 psi.

The curves below compare the test performance of one of the new compositions with a friction material that has been used successfully in millions of automatic transmissions. For more information, and a copy of our booklet on these new friction facings, write to Armstrong Cork Company, Industrial Division, 7216 Durham Street, Lancaster, Pennsylvania.

The curves shown below, called "fade curves," were plotted from tests run on the Armstrong wet friction dynamometer. In this machine, a single test clutch plate (7½" O.D., 6¼" I.D., faced both sides) is engaged and disengaged thousands of times, each time absorbing the 28,000 foot-pounds of kinetic energy which the machine develops at 1,000 rpm. During each engagement, three factors are graphically recorded: maximum coefficient of friction, minimum coefficient of friction, and stopping time.



This fade curve shows the performance under test of a typical clutch plate faced half-and-half with a standard resilient cork facing and a resin-saturated paper. This type facing has been used with excellent results in millions of automatic transmissions. Ideally, these curves would be parallel, reflecting no change from the first engagement to the last. Under severe test, however, the coefficient of friction curves both fall off, while the stopping time increases.



This fade curve shows the performance of the new Armstrong FM-45 material during a test covering 7,500 engagements. Note that the curves more nearly approach the horizontal than the previously acceptable material charted above. This indicates a marked improvement in actual performance.

FOR DEPENDABLE CAR PERFORMANCE, THESE VITAL SPOTS DEMAND THE DEPENDABILITY OF AMERICAN QUALITY FELTS

Lubrication—Sealing—Insulating—Cushioning—Anti-Rattle—Anti-Squeak—Sound Absorption
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1 FAN BEARING OILER. 2 WATER PUMP PACKING AND OILER. 3 GENERATOR BEARING SEALS. 4 GENERATOR AND STARTER LUBRICATING WICKS. 5 OIL FILTER. 6 BATTERY POSITIVE TERMINAL ANTI-CORROSION WASHER. 7 BRAKE BOLT OILER. 8 STEERING KNUCKLE TO TIE ROD DUST SEAL AND FLANGE JOINT SEAL. 9 STEERING ARM BEARING OILER. 10 FRONT WHEEL BEARING SEAL. 11 WHEEL BRAKE SHOE OILER. 12 CARBURETOR. 13 STEERING COLUMN GROMMET. 14 TRANSMISSION OIL SEAL WASHER. (SEAL ASSEMBLY TRANSMISSION BEARING) 15 DRIVE SHAFT DUST SEAL. 16 TOE BOARD AND FLOOR BOARD LINER. 17 CLUTCH HOUSING PAN DUST SEAL. 18 BODY TO CHASSIS STRIPS. 19 WINDSHIELD WIPER PIVOT ARM MOUNTING. 20 WINDOW LIFT LUBRICATORS. 21 DOOR PANEL INSULATOR. 22 FLOOR BOARD PARTS. 23 UNIVERSAL OIL SEAL. 24 TURRET TOP INSULATION. 25 WINDOW RUN CHANNEL. 26 REAR AXLE DRIVE SHAFT SEAL. 27 AXLE PINION DRIVE BEARING SEAL. 28 UPHOLSTERY RISER STRIPS. 29 SPRING COVER LINING. 30 REAR PANEL WEATHERSTRIP. 31 FUEL TANK STRAP GASKET.

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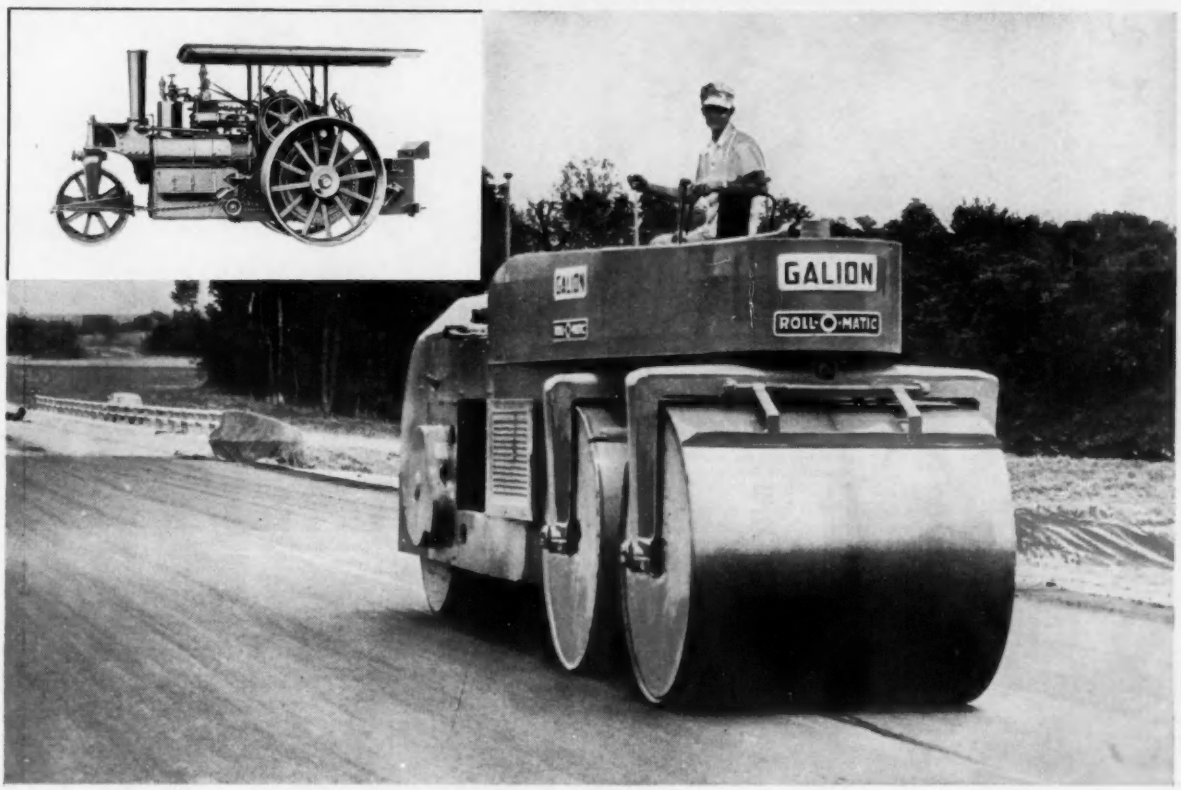
Some Additional Applications of felt: Clutch release link lever oiler • Window anti-squeak • Fuel tank support lining • Brake shoe anchor pin washer • Drag link dust cover • Intermediate steering arm bearing seal • Windshield wiper motor washer • Toe and floor board anti-squeak • Solenoid cover gasket • Heater core to housing filler • Spindle bolt grease retainer • Spindle bolt dust washers • Radius rod felt • Hydraulic lift spring seat • Door bumpers • Pedal pads and seals • Dash liners • Oil retainers • Polishing felts, for glass, metal and paint • Door liners • Ventilator valve seals • Weather seals • Hood lace filler • Moulding shim • Timing gear cover pad • Accelerator rod pad • Fuel tank shim • Propeller shaft spline oiler • Paint filter bags • Crankcase oil filter cap • Brake dirt seals • Defroster control valve seal • Hand brake cable clamp seal • Windshield division filler • Pinion bearing retainer packing • Horn wire locator felt • Oil sabre dust washer • Fender welt felt • Spring oiler felt • Spring bumpers • Gas filling protector pads • Rocker arm seals • Chafing strips for convertible tops • Upholstery padding • Radio selector pads • Thrust bearing inserts • Cab roof lining • Antenna weather seal • Blankets for protection during assembly and service • Factory table pads • Glycerine pads for windshield wipers •

ALLISON salutes GALION's 50 Years of Progress

The Allison Division of General Motors proudly congratulates The Galion Iron Works on a half-century devoted to the design and manufacture of better road-building tools

YESTERDAY—This early Galion "steamroller" was a road-building miracle in its day. Key to its efficiency was the smooth, quick reversing possible with steam power. From this model Galion went on to more modern motor rollers.

TODAY—Galion's 3-axle tandem Roll-O-Matic is the result of half a century of manufacturing skill. And its modern TORQMATIC DRIVE brings back the smoothness of steam-engine reversing. The Galion Roll-O-Matic is one of the most important tools of today's road-builder.



Through constant research and development Galion has grown from a modest beginning in 1907 to its present position as one of the world's leading manufacturers of road rollers.

Allison is proud to be playing an important role in Galion's latest highway construction equipment —the Galion Roll-O-Matic. Allison TORQMATIC Converters make these streamlined road rollers completely modern, pointing the way toward Galion's continued progress as it begins another 50 years of service to the American road-building industry.

GM TORQMATIC

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IF you've invested in automatic forging equipment, don't be robbed of your profits by the steel you're forging. Unless it's uniform, you'll be interrupting production to change your setup. These interruptions take time, limit the availability of expensive automatic equipment.

When you use Timken® steel, you get the uniformity you need. Timken fine alloy steel is uniform from bar to bar, heat to heat, order to order. It makes your automatic forging equipment more available—at no extra cost—because you can forge without interruption.

We assure complete uniformity by taking extra quality control steps. For example, we were the first steel manufacturer in the U.S. to use a magnetic stirrer for molten steel. It distributes alloys equally, keeps temperature uniform, and works the slag continuously.

To assure still further uniformity, your order is handled individually. Conditioning procedures are targeted to meet your end use requirement. To limit variations within an order—as well as from order to order—we stamp each bar to identify its heat.

To increase the availability of your automatic forging equipment —at no extra cost—always specify Timken fine alloy steel. You'll get money-saving performance and uniform results every time. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

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